



# THE UNIVERSITY *of* EDINBURGH

This thesis has been submitted in fulfilment of the requirements for a postgraduate degree (e.g. PhD, MPhil, DClinPsychol) at the University of Edinburgh. Please note the following terms and conditions of use:

This work is protected by copyright and other intellectual property rights, which are retained by the thesis author, unless otherwise stated.

A copy can be downloaded for personal non-commercial research or study, without prior permission or charge.

This thesis cannot be reproduced or quoted extensively from without first obtaining permission in writing from the author.

The content must not be changed in any way or sold commercially in any format or medium without the formal permission of the author.

When referring to this work, full bibliographic details including the author, title, awarding institution and date of the thesis must be given.

# Lifestyle Interventions to Improve Educational Attainment in Overweight or Obese Children

Anne Martin



THE UNIVERSITY  
*of* EDINBURGH

Doctor of Philosophy  
The University of Edinburgh  
2014

## Declaration

I declare that this thesis has been composed solely by the author and that no aspect of the work has been submitted for any other degree or professional qualification. I confirm that the work contained in this thesis is the author's own with the exception of the following sections where the author made substantial contributions as part of a research group;

Cochrane Systematic Review (Chapter 3)

Candidate contribution detailed in Appendix 8.1.1

Qualitative study (Chapter 5)

Candidate contribution detailed in Appendix 8.1.2

---

Anne Martin

---

Date

## Acknowledgements

This work would not have been possible without the guidance and support of several people. First and foremost, I like to express my gratitude to Dr David Saunders who not only guided and supported me with his expertise throughout the PhD but also made me value and believe in my research at difficult times. Your commitment has been overwhelming. I could not have asked for a better supervisor and I feel honoured that I was your first PhD student! I would also like to thank Dr John Sproule for giving me the opportunity to do this research, to grow with it and to explore the possibilities and boundaries in the research world. Your support and encouragement have been invaluable. Thank you to Dr Sarah McGeown for her enthusiastic and constructive support during the last months in the completion of this thesis and for her fresh and objective view on my research. Your contribution has made this thesis what it is today. I also like to thank Dr Susan Shenkin for sharing her expertise and providing valuable input during the completion of the Cochrane review. I am also very grateful to Dr Ailsa Niven for her tenacity in supporting and guiding me throughout the final study of this thesis.

My thanks go also to my research collaborators Dr Laura Stewart at the Paediatric Overweight Service Tayside, Jodie Montgomery at Get Going, Stan Wilson at Angus Council, Lesley Murray at Dundee City Council, and Duncan Heather at the Health Informatics Centre. Their contribution has been invaluable to make this research happen. In addition, I like to thank all families who participated in my research.

A special thanks to Kostas for sharing his overwhelming fascination for research. Your experience, motivation and encouragement have helped me substantially to embark on this thesis. Thank you for inspiring me to go this route and to become a researcher.

Last but not least, I like to thank my wonderful family and friends back home in Germany. This work would not have been possible without your constant encouragement and belief in me. In particular, I like to thank Nadine, Anja and Sandrine. Thank you for being there whenever I needed you and for just being you.

## **Abstract**

**INTRODUCTION:** Childhood obesity is associated with increased physical and psychosocial co-morbidities, and with lower cognitive function and educational attainment. Clinical guidelines recommend lifestyle interventions (healthy diet, increased physical activity and decreased sedentary behaviour) for the treatment of childhood obesity. Lifestyle interventions are known to benefit cognitive function and educational attainment in normal weight children. However, it is not known whether the same benefits occur when lifestyle interventions are used to treat overweight and obese children.

**AIM & OBJECTIVES:** The aim of this thesis was to assess the effect of lifestyle interventions on educational attainment in overweight and obese children in three studies: Objective 1: Assess the efficacy of lifestyle interventions for improving educational attainment. Objective 2: Establish the feasibility of assessing the effectiveness of a childhood primary care weight management programme on educational attainment. Objective 3: Investigate the potential mechanisms for how lifestyle interventions for weight management might benefit educational attainment of overweight children.

**METHODS:** Study 1: Systematic (Cochrane) review and meta-analysis of randomised controlled trials of single or multicomponent lifestyle interventions in children aged 3-18 years. Study 2: Quasi-experimental study linking childhood weight management data of children 5-15 years with education data from local education authorities in Scotland. Study 3: Qualitative study designed to gain insight into overweight and obese children's and their parents' perceptions and experiences in school and weight management programme obtained from focus groups and interviews.

**RESULTS:** Study 1: The systematic review included six studies of 674 overweight and obese children and adolescents. Findings indicated that school-based healthy lifestyle education combined with nutrition interventions can produce small improvements in overall school attainment. Single component physical activity

interventions produced small improvements in mathematics attainment and associated cognitive skills (executive function, and working memory). There was no evidence of an effect of any lifestyle intervention on reading, vocabulary and language attainment, attention, inhibitory control, and simultaneous processing. Study 2: Cross-sectorial administrative data-linkage was shown to be feasible. This pilot study showed no evidence of a beneficial effect of a primary care child weight management programme on reading, writing and mathematics attainment in overweight and obese children. However, a definitive study to properly assess the effectiveness of lifestyle interventions outside the research environment is clearly feasible in Scotland. Study 3: The themes emerging from focus groups and interviews were body weight related school experiences, attitudes towards school, obesity and school performance, and influence of weight management. Participants perceived that being overweight can benefit educational attainment because a lack of friends means they are less distracted from learning. Low psychosocial well-being experienced by the participants was improved after taking part in a weight management programme. Parents understood this benefit could potentially impact positively on school experiences and attainment in the long-term.

**CONCLUSION:** Given the high prevalence of childhood obesity, educational and cognitive outcomes could be improved, to some extent, in a very large number of school-aged children through increased physical activity and nutrition education intended for weight management. Health policy makers should be aware of these potential additional benefits when promoting physical activity and healthy eating in schools. Childhood weight management programmes exist widely and thus provide an opportunity to evaluate their impact on educational outcomes in the community. Implemented child weight management programmes may benefit from improved recording of routine data and from obtaining participants' administrative education data to ensure adequate support and supervision of this vulnerable population. In addition, weight management programmes could consider promoting psychosocial well-being of participants to potentially benefit both health and educational outcome. Lifestyle interventions for obese children and adolescents are under-investigated particularly with regard to a) efficacy in clinical and community settings, b) short

and long-term effectiveness for improving educational attainment and c) mechanisms of benefit on educational attainment and cognitive function.

# Table of Contents

Declaration.....	2
Acknowledgements.....	3
Abstract.....	4
List of Tables.....	13
List of Figures .....	14
List of Abbreviations.....	16
List of Publications .....	18
CHAPTER 1: Introduction .....	19
1.1. Link between health and education.....	19
1.2. Childhood obesity .....	21
1.2.1. Definition of childhood obesity .....	21
1.2.2. Prevalence .....	22
1.2.3. Health Consequences.....	23
1.2.4. Causes of childhood obesity .....	24
1.2.5. Prevention and Treatment.....	26
1.3. Aim.....	31
1.4. Thesis structure .....	32
1.5. Method of inquiry .....	33
CHAPTER 2: Literature Review .....	35
2.1. Association between childhood obesity and educational attainment (Systematic review).....	35
2.2. Association between childhood obesity and cognitive function .....	80
2.3. Association between childhood/youth obesity and ‘future success’ .....	94
2.4. Potential confounding and mediating factors explaining the association between childhood obesity, educational attainment and associated outcomes	109



2.5. Lifestyle interventions for improvement of educational attainment and associated achievements.....	120
2.5.1. How the interventions might work in the general child and adolescent population .....	120
2.5.2. How the interventions might work in overweight and obese children and adolescents.....	127
Chapter 3: Lifestyle Interventions for Improving School Achievement in Overweight or Obese Children and Adolescents (Cochrane Systematic Review).....	130
3.2. Introduction .....	130
3.2.1. Rational for conducting this systematic review.....	131
3.2.2. Aim and objective.....	132
3.3. Methods .....	132
3.3.1. Criteria for selecting studies for this review.....	132
3.3.2. Search methods for identification of studies.....	135
3.3.3. Data collection and analysis.....	136
3.4. Main results.....	141
3.4.1. Results of the search .....	141
3.4.2. Risk of bias in included studies .....	146
3.4.3. Effects of interventions.....	149
3.4.3.1. Primary outcomes .....	149
3.4.3.2. Secondary outcomes .....	154
3.4.4. Sensitivity analysis .....	158
3.5. Discussion.....	159
3.5.1. Summary of main results .....	159
3.5.2. Overall completeness and applicability of evidence .....	160

3.5.3. Quality of the evidence.....	162
3.5.4. Potential biases in the review process .....	164
3.5.5. Agreements and disagreements with other studies or reviews .....	166
3.6. Conclusions .....	167
3.6.1. Implications for practice .....	167
3.6.2. Implications for research .....	168
CHAPTER 4: Effectiveness of childhood weight management on participant's educational attainment.....	170
4.1. Introduction .....	170
4.1.1. Study rationale .....	170
4.1.2. Aims and Hypotheses .....	178
4.2. Methods .....	179
4.2.1. Study design .....	179
4.2.2. Intervention characteristics .....	180
4.2.3. Participant inclusion criteria .....	182
4.2.4. Measures .....	182
4.2.5. Data management .....	190
4.2.6. Data analysis .....	191
4.3. Results.....	195
4.3.1. Feasibility of linking weight management with education data .....	196
4.3.2. Effectiveness of weight management on post-treatment attainment	209
4.4. Discussion.....	223
4.4.1. Feasibility of linking weight management and education data in Scotland.....	223
4.4.2. Effectiveness of child weight management on participants' educational attainment .....	226

4.4.3. Implications for research .....	228
4.4.4. Implications for practice .....	230
4.5. Conclusion .....	230
CHAPTER 5 – Body weight and school experiences: Perceptions of overweight children and their parents .....	233
5.1. Introduction .....	233
5.1.1. Aims and Objectives .....	236
5.2. Methods .....	236
5.2.1. Study design and recruitment .....	236
5.2.2. Participants .....	238
5.2.3. Data collection procedures.....	240
5.2.4. Data analysis .....	241
5.3. Results .....	243
5.3.1. Participant characteristics .....	243
5.3.2. Adolescent girls' perspectives and experiences .....	244
5.3.3. Parents' perception .....	263
5.4. Discussion.....	278
5.4.1. Strengths and Limitations.....	284
5.4.2. Implications for practice and research .....	287
5.5. Conclusion .....	288
CHAPTER 6 – Discussion & Conclusion .....	290
6.1. Summary of findings .....	290
6.2. Importance of the research .....	292
6.3. Strengths and limitations.....	294
6.4. Implications for future research.....	296
6.5. Implications for practice .....	297
6.6. Conclusion .....	299

7. References.....	302
8. Appendices .....	329
8.1 Contribution to research.....	329
8.1.1 Contribution to the systematic (Cochrane) review (study 1).....	329
8.1.2 Contribution to the qualitative study (study 3) .....	329
8.2 Chapter 3 .....	330
8.2.1 Search strategy .....	330
8.2.2 Additional methods .....	334
8.2.3 Characteristics of included studies.....	337
8.2.4 Risk of Bias Table .....	348
8.3. Chapter 4 .....	354
8.3.1 NHS Tayside Caldicott Approval.....	354
8.3.3 NHS Tayside Research and Development Management Approval...	357
8.3.4 Health Informatics Centre Data user Agreement .....	359
8.3.5 Data Sharing Agreement Dundee City Council .....	362
8.3.6 Data Sharing Agreement Angus Council.....	365
8.3.7 Multiple Imputations models.....	368
8.4 Chapter 5 .....	369
8.4.1 NHS Lothian REC Approval .....	369
8.4.2 NHS Lothian Research and Development Office Approval .....	373
8.4.3 Moray House School Research Ethics Committee Approval .....	377
8.4.4 Parents/Carers Information Letter .....	378
8.4.5 Young Person Information Letter (age 10–12 years) .....	383
8.4.6 Young Person Information Letter (age 13–15 years) .....	389
8.4.7 Parents/Carers Consent Form .....	395

8.4.8 Young People Consent Form .....	396
8.4.9 Young Person Assent Form .....	397
8.4.10 Demographic Questionnaire .....	398
8.4.11 Focus group/interview Topic Guide.....	401

## List of Tables

Table 1.1: Prevalence of childhood overweight and obesity in the UK .....	23
Table 2.1: Regression coefficients and effect sizes of attainment scores from regression models (random effects) of cross-sectional studies with objectively assessed attainment measures .....	44
Table 2.2: Studies categorised by direction and impact of the association between child obesity and educational attainment .....	56
Table 2.3: Association between childhood overweight/obesity and educational attainment – Cross-sectional studies .....	62
Table 2.4: Association between overweight/obesity and educational attainment – Longitudinal studies .....	77
Table 2.5: Association between child overweight and cognitive functioning .....	90
Table 2.6: Association between childhood overweight/obesity and future success	101
Table 4.1: Attainment by schooling stage in the 5-14 Curriculum and Curriculum for Excellence (CfE).....	174
Table 4.2: Attainment expectation by attainment level and schooling stage.....	189
Table 4.3: Summary of the number of available participant data by local education authority.....	204
Table 4.4: Number of children with assessed pre/post-treatment educational attainment.....	207
Table 4.5: Proportion of missing values for predictor variables.....	208
Table 4.6: Odd ratios of meeting attainment expectations by completion group and in relation to the number of sessions attended.....	216
Table 4.7: Odd ratios and confidence intervals of the effect of number of POST sessions attended on meeting writing attainment expectations adjusted for gender (reference = boys). .....	217
Table 4.8: Socio-demographic, treatment-related and school-related participant characteristics at baseline.....	218
Table 4.9: Pre/post intervention comparison of the proportion of children meeting attainment expectation by completion group.....	222

## List of Figures

Figure 2.1: PRISMA diagram of search results and selection of included studies ...	39
Figure 2.2: Proportion (%) of studies meeting quality criteria by direction of the obesity-attainment association.....	50
Figure 2.3: Confounding and/or mediating factors and potential causal links in the association between childhood obesity and educational attainment based on the literature reviewed. ....	119
Figure 3.1: Study selection flow diagram .....	142
Figure 3.2: Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included.....	146
Figure 3.3: Forrest plot of the effect of lifestyle interventions versus standard care on overall school attainment .....	151
Figure 3.4: Forrest plot of the effect of lifestyle interventions versus standard care on mathematics attainment.....	152
Figure 3.5: Forrest plot of the effect of lifestyle interventions versus standard care on reading attainment.....	153
Figure 3.6: Forrest plot of the effect of lifestyle interventions versus standard care on attention.....	155
Figure 3.7: Forrest plot of the effect of lifestyle intervention versus standard care on executive function .....	156
Figure 3.8: Forrest plot of the effect of lifestyle intervention versus standard care on BMI z-scores.....	158
Figure 4.1: Flowchart of ad-hoc data-linkage of a child weight management database and local pupil databases.....	180
Figure 4.2: Feasibility measures flow chart. NHS: National Health Service, LEA: Local Education Authority, POST: Paediatric Overweight Service Tayside. ...	183
Figure 4.3: Study approval flow chart. POST: Paediatric Overweight Service Tayside, NHS: National Health Service, R&D: Research and Development Office, REC: Research Ethics Committee, HIC: Health Informatics Centre. ...	197
Figure 4.4: Timeline of data sharing.....	202
Figure 4.5: Proportion of girls meeting writing attainment expectations pre and post intervention by comparison groups .....	214
Figure 4.6: Proportion of children meeting attainment expectations by comparison groups. ....	215

Figure 5.1: Lower order and basic themes of the higher order theme ‘Body weight related school experiences’ .....	245
Figure 5.2: Basic and lower order themes of the higher order theme ‘Obesity and school performance’ .....	256
Figure 5.3: Basic and lower order themes of the topic ‘Influence of weight management’.....	260
Figure 5.4: Higher and lower order themes identified from the focus group and interview with parents/carers. ....	264
Figure 5.5: Lower order and basic themes of parents’ perceptions about body weight related school experiences. ....	265
Figure 5.6: Flow diagram of the link between young peoples’ body weight and school performance and the role of Get Going to influence school experiences .....	280



## List of Abbreviations

AifL	Assessment is for Learning
ANOVA	Analysis of Variance
ANCOVA	Analysis of Covariance
BDNF	Brain-derived neurotrophic factor
BF	Body fat
BIA	Bioelectrical Impedance Analysis
BMI	Body mass index
CAT	Canadian Achievement Test
CDC	Centre for Disease Control
CfE	Curriculum for Excellence
CHI	Community Health Index
CI	Confidence Interval
Cito	Central Institute for Test Development
DEXA	Dual-energy X-ray absorptiometry
df	Degree of freedom
ECLS-K	Early Childhood Longitudinal Study – Kindergarten Cohort
EPODE	Ensemble Prévenons l’Obésité Des Enfants
ERIC	Education Resource Information Centre
ES	Effect size
FE	Fixed effect
FTO	Fat mass and obesity associated
FTP	File Transfer Protocol
GRADE	Grading of Recommendations Assessment, Development and Evaluation
GPA	Grade Point Average
HEAT	Health Improvement, Efficiency, Access and Treatment
HIC	Health Informatics Centre
IQ	Intelligence quotient
IRT	Item Response Theory
ISD	Information Service Division
IOTF	International Obesity Task Force

LEA	Local Education Authority
MANCOVA	Multiple Analysis of Covariance
MD	Mean difference
MI	Multiple imputations
MRC	Medical Research Council
N	Number of participants/studies
NHANES	National Health and Nutrition Examination Survey
NHS	National Health Service
OB	Obese
OR	Odds ratio
OW	Overweight
P	Probability value
PAC	Privacy Advisory Committee
PE	Physical Education
RCT	Randomised controlled trial
R&D	Research and Development Office
REC	Research Ethics Committee
POST	Paediatric Overweight Service Tayside
SAIL	Secure Anonymised Information Linkage
SCN	Scottish Candidate Number
SCOTT	Scottish Overweight Treatment Trial
SD	Standard deviation
SDS	Standard Deviation Score
SES	Socio-economic status
SHIP	Scottish Health Informatics Programme
SIMD	Scottish Index of Multiple Deprivations
SMD	Standardised mean difference
SQA	Scottish Qualification Assessment
TASC	Tayside Medical Science Centre
WC	Waist circumference
WHO	World Health Organisation
WRAT	Wide Range Achievement Test

## List of Publications

### *In Preparation*

**Martin A**, Saunders DH, McGeown S, Sproule J. Childhood obesity and educational attainment: Systematic review evidence from prospective cohort studies. Intended for submission to the International Journal of Obesity

**Martin A**, Saunders DH, Stewart L, Sproule J. Informing child weight management programmes using administrative school data: Challenges and practical implications of pragmatic research using cross-sectorial data-linkage. Intended for submission to the Scottish Medical Journal

**Martin A**, Niven A, Saunders DH, Sproule J. Can childhood weight management benefit obese adolescents in school? Intended for submission as Short Communication to Pediatric Obesity

### *Journal Articles*

**Martin A**, Saunders DH, Shenkin SD, Sproule J. (2014) Lifestyle intervention for improving school achievement in overweight or obese children and adolescents. Cochrane Database of Systematic Review, Issue 3. Art. No.: CD009728. DOI: 10.1002/14651858.CD009728.pub2.

### *Response Letter*

**Martin A**, Saunders D.H., Shenkin S.D. 'Seat of Learning'? (2011) British Medical Journal. Online Publication. 11 August 2011  
[http://www.bmj.com/content/343/bmj.d4273.full/reply#bmj\\_el\\_268449](http://www.bmj.com/content/343/bmj.d4273.full/reply#bmj_el_268449)

### *Conference Abstract*

**Martin A**, McGeown S, Saunders DH. Childhood obesity and educational attainment: Evidence from prospective cohort studies. UK Congress on Obesity. Birmingham, UK. 15-16 September 2014

## **CHAPTER 1: Introduction**

### **1.1. Link between health and education**

The topic of this thesis evolves from the considerably large body of evidence indicating that pupil's health and educational attainment are strongly related. Researchers from the fields of Health, Education and Economics have consistently concluded that health and education are bi-directionally causally related. That is, in general, healthy children and adolescents obtain better educational outcomes and more years of successful schooling lead to better health outcomes (Currie, 2009; Eide & Showalter, 2011; Suhrcke & de Paz Nieves, 2011). However, the causal link between these health and educational areas of interest might be indirect through the influence of other factors on both health and education (Dadaczynski, 2012; Eide & Showalter, 2011).

The effect of education on health outcomes was firstly evaluated using natural experiments. In the education context a natural experiment is characterised by changes in schooling laws or policies in one region but not in the other which assigned populations randomly to intervention and control groups. Post-intervention outcomes of both groups were then used to obtain causal estimates (Eide & Showalter, 2011). Changes in schooling laws towards compulsory schooling and implementation of education policies had beneficial effects on mortality rates, self-reported health, and the probability of hospitalisation (Eide & Showalter, 2011). The education literature proposed three pathways to explain how education affects health: i) education increases the knowledge of health related issues and thus increases the odds of positive health behaviours, ii) more years of schooling and higher educational degrees increase labour market opportunities which are associated with higher income and better work place conditions, which in turn may act beneficially on health, iii) educational success may benefit psychological and social factors

associated with health (Egerter et al., 2009). For example, negative school experiences such as poor educational attainment can lead to anxiety, depression and frustration which may cause mental health issues (Dadaczynski, 2012).

Several health-related risk factors and health conditions were identified which can have a negative impact on education. Based on natural experiments from twin/sibling studies, health risk factors impacting on education range from harmful foetal health conditions (e.g. influenza pandemic, radiation exposure, maternal alcohol intake) and low birth weight and height, to mental illness (e.g. depression) and injuries (Eide & Showalter, 2011; Suhrcke & de Paz Nieves, 2011; Symons et al., 1997). Suhrcke and de Paz Nieves (2011) reviewed 53 publications on health-related behaviour of children and youth. Findings suggested that smoking and poor nutrition have a stronger harmful impact on educational outcomes than alcohol and drug use. They also indicated that participation in physical activity has beneficial effects on educational attainment, while sleeping disorders and overweight and obesity are negatively associated academic achievement (Suhrcke & de Paz Nieves, 2011).

The effect of health on education and vice versa is also suspected to be influenced by one or more factors, thus there might be an indirect relationship. One factor which has been extensively discussed in the literature is socio-economic status. Research has indicated that a low socioeconomic status is associated with both negative health behaviours and health outcomes and lower academic success (Dadaczynski, 2012). Other endogenous and exogenous factors include cognitive ability, social support, self-esteem and relationship with peers and teachers (Suhrcke & de Paz Nieves, 2011). Twin and sibling studies have confirmed that family characteristics may influence the link between health and education (Oreopoulos et al., 2008). Since health status, educational outcomes and other factors during childhood and adolescence are likely to affect later life health and achievements, there might be an intergenerational link between health and education. Health and educational outcomes of next generations can be influenced through factors such as social status, perceived value of the future, social networks, community and school environment, neighbourhood and political environment (Suhrcke & de Paz Nieves, 2011).

## 1.2. Childhood obesity

Childhood overweight and obesity was identified as one health-risk factor which may have a negative impact on educational attainment. In this section of Chapter 1, I provide the rationale for why childhood obesity is a risk factor that may need particular attention. I give an overview of the health condition by defining childhood obesity and outlining the prevalence, by discussing health consequences, causes and prevention and the treatment strategies used globally and in the Scottish context more specifically.

### 1.2.1. Definition of childhood obesity

Overweight and obesity are conditions of excessive body fat accumulation. In clinical practice paediatric overweight and obesity are commonly identified using age and gender specific body mass index (BMI) percentiles, BMI standard deviation scores, BMI cut-offs, and waist circumference (WC) percentiles relative to a reference population (Reilly et al., 2010; Rolland-Cachera, 2011). The primary criteria used to define overweight and obesity are;

- Overweight: BMI or WC 85<sup>th</sup> percentile – 95<sup>th</sup> percentile for population monitoring; BMI 91<sup>st</sup> percentile for clinical assessment; BMI > +1 standard deviation of the average
- Obesity: BMI or WC > 95<sup>th</sup> percentile for population monitoring; BMI > 98<sup>th</sup> percentile for clinical assessment; BMI > +2 standard deviations of the average

The BMI cut-offs from the International Obesity Task Force (IOTF) are also an often used definition of overweight/obesity. These age-specific BMI cut-offs were constructed to match the overweight and obesity definition for adults (BMI 25 kg/m<sup>2</sup> and BMI 30kg/m<sup>2</sup>, respectively) (Cole et al., 2000). Recently, the IOTF BMI cut-offs were reformulated which allow BMI to be expressed as a standard deviation

or percentile (Cole & Lobstein, 2012). This improves the comparability of BMI values with the WHO definitions of overweight and obesity.

### **1.2.2. Prevalence**

Childhood obesity has reached an epidemic level. The World Health Organization (WHO) regards childhood obesity as one of the most serious global public health challenges for the 21st century (WHO, 2014). The IOTF estimated that globally 200 million school-aged children are overweight; 40-50 million of those are classified as being obese (IOTF, 2010). In the USA the prevalence of overweight and obese children and adolescents (2-19 years) was 32% in 2010 (Ogden et al., 2012). In Europe one in four children are overweight or obese. The highest prevalence of overweight (IOTF cut-offs) was found in southern European countries with 20-35%, while in northern Europe the prevalence was 10-20% (Lobstein et al., 2004). Recent results from the Scottish Health Survey indicate that in 2012 33.6% of the boys and 27.4% of the girls aged 2-15 years are overweight or obese, relative to the 1990 UK reference population. The highest overweight prevalence was found in post-adolescent (12-15 years) boys and girls (Bromley et al., 2013). The National Child Measurement Programme in England (2011) has shown that 22.6% of children at primary school reception and 33.4% of children in their final year of primary school were either overweight or obese, relative to the 1990 UK reference population. For the latter, more children were obese (19.0%) than overweight (14.4%) (NHS, 2010). Figure 1 shows the prevalence of childhood overweight and obesity in the UK and Ireland.

The global rise of childhood obesity is not only present in high-income countries. Middle- and low-income countries showed also a high prevalence of childhood overweight, including obesity (Swinburn et al., 2011). For example, in India 21% of the boys and 18% of the girls aged 2-17 years were overweight (IOTF cut-offs) in 2008 and in Mexico about 28% of children aged 6-17 years were overweight (IOTF cut-offs) in 2006 (IASO, 2011).

**Table 1.1: Prevalence of childhood overweight and obesity in the UK**

Country	Year	Age (years)	Obese		Overweight (including obese)		Data Source
			Boys	Girls	Boys	Girls	
Scotland <sup>1</sup>	2012	2-15	19.7%	13.7%	33.6%	27.4%	Scottish Health Survey
England <sup>1</sup>	2011	2-15	17.1%	14.8%	31.4%	29.2%	Health Survey for England
Wales <sup>1</sup>	2012	2-15	20.0%	19.0%	35.0%	33.0%	Welsh Health Survey
Northern Ireland <sup>2</sup>	2011/12	2-15	10.0%	10.0%	31.0%	31.0%	Healthy Survey Northern Ireland

<sup>1</sup> Overweight: BMI 85th percentile, obesity: BMI 95th percentile relative to the 1990 UK reference population, <sup>2</sup> IOTF cut offs; Source: Adapted from the National Obesity Observatory

([http://www.noo.org.uk/NOO\\_about\\_obesity/child\\_obesity/UK\\_prevalence](http://www.noo.org.uk/NOO_about_obesity/child_obesity/UK_prevalence), accessed 17 December 2013)

### 1.2.3. Health Consequences

Childhood overweight and obesity is associated with increased morbidity affecting many organ systems (Han et al., 2010). Overweight and obese children have increased levels of cardiometabolic risk factors such as dyslipidaemia, hyperinsulinaemia, and endothelial dysfunction (Reilly et al., 2003). The serious health consequences of elevated body fatness at a young age can be atherosclerosis, hypertension, type 2 diabetes, fatty liver disease, and metabolic syndrome (Calcaterra et al., 2008; Daniels, 2009). In Europe, 35% of 268,000 overweight children had increased levels of blood pressure (D l'Allemand-Jander, 2010). Fatty liver disease was diagnosed in 11-29% of European overweight children and youth (D l'Allemand-Jander, 2010). Obesity associated disorders in childhood include also psychosocial (e.g. depression, anxiety), respiratory (e.g. obstructive sleep apnoe) and skeletal (e.g. musculo-skeletal discomfort) disorders (Han et al., 2010; Puder & Munsch, 2010). It is suggested that an early appearance of cardiometabolic risk factors over a long period of time, as from childhood into adulthood, increases the chance of severe health problems (Halpern et al., 2010). A recent systematic review



of 39 studies including from 181 to 1.1 million participants indicated that increased childhood BMI is associated with adult type 2 diabetes, hypertension and coronary heart disease (Park et al., 2012). Obesity at a young age, its persistence through adulthood, and the rising incidence of chronic diseases in children and adolescents is a matter of clinical and public health concern (Daniels & Greer, 2008; Haines et al., 2007).

#### **1.2.4. Causes of childhood obesity**

The main contributor to the dramatic rise in the prevalence of childhood obesity lies in the change of our environment; namely the change in type and amount of food and the development of industry and technology (Swinburn et al., 2011; WHO, 2003). Children's dietary patterns were influenced by the availability of affordable, palatable, persuasively advertised high-energy dense food (e.g. fast food, sweets, and salty snacks) and beverages (e.g. sugar-sweetened soft drinks) which led to an increase in energy intake. Simultaneously, motorised transport, urbanisation, infrastructure and technology requiring low physical demands at home, in school and for leisure time contributed to engagement in activities of low energy expenditure (Swinburn et al., 2011). The combination of both high energy intake and low energy expenditure causes excessive fat accumulation in the body; in this context the term '*obesogenic*' environment evolved.

Another factor associated with the development of childhood obesity and most likely related to environmental changes is sleep deprivation. Two systematic reviews were published and both including 11 studies (Cappuccio et al., 2008; Chen et al., 2008) suggested that children with shorter sleep duration were 1.6 times more likely to become overweight or obese compared to children who sleep longer. A gender difference was apparent in Chen et al.'s (2008) findings. Sleep restricted boys were 2.5 times more likely to become overweight or obese compared to sleep restricted girls whose likelihood of becoming overweight or obese was 1.24. No statistically significant difference by body weight status (overweight versus obese) and age group was found. Meta-regression analyses suggested that sleeping one additional hour was associated with a decreased risk of overweight or obesity by 9% (Chen et al., 2008).

Sleep deprivation is associated with changes in hormone levels relevant for appetite regulation and food intake in the way that hunger and appetite signals (ghrelin) are elevated and satiety signals are decreased (leptin) resulting in increased energy intake (Perez-Chada et al., 2009).

Genetic and endocrine disorders can be involved in the development of childhood obesity; however these cases contribute minimally to the prevalence of childhood obesity (Speiser et al., 2005).

Monogenetic obesity syndromes are characterised by deletion or disruption of a single gene crucial for metabolic and appetite regulation (e.g. leptin mutation, leptin receptor mutation) (Speiser et al., 2005; Yang et al., 2007). Genetic variations of the fat mass and obesity associated (FTO) gene, which is linked to the development of obesity in some children, also falls in the monogenetic syndrome category (Dina et al., 2007; Frayling et al., 2007). Multigenetic disorders affect more than a single gene and are associated with excessive adipose tissue. These are present in health conditions such as Prader-Willi Syndrome, Bardet-Bidl Syndrome and Alström Syndrome (Kousta et al., 2009). Endocrine/hypothalamic disorders include, for example, hypothalamic-hypothyroidism, hypothalamus trauma or tumour, Cushing disease, and growth hormone resistance (Speiser et al., 2005). Monogenetic, multigenetic and endocrine/hypothalamic disorders influence appetite and satiety regulation causing increased food intake and subsequent weight gain (Speiser et al., 2005).

The sharp increase in the prevalence of obesity over a short period of time indicates that weight related changes cannot be explained by genetic factors alone; however there is evidence of an interplay between genes and the environment. Migration studies showed that migration from a non-obesogenic environment (e.g. a rural part of a country) into an obesogenic environment (e.g. an urban part of a country) was associated with weight gain and the next generation became obese while family members that did not migrate remained lean (Yang et al., 2007), illustrating a strong influence of environmental factors. Interestingly, people seem to vary in their susceptibility to develop obesity when exposed to an obesogenic environment. A

high-risk profile of genes that regulate energy metabolism, appetite and satiety, predispose individuals to develop obesity when they enter a high-risk environment (Yang et al., 2007).

In summary, the primary causes of childhood obesity appear to be environmental; however these can be more influential when a genetic predisposition exists.

### **1.2.5. Prevention and Treatment**

Given the obesogenic environment as a major reason for the development of overweight and obesity, prevention and treatment initiatives call for changes at all levels of the obesogenic environment: the individual level (children and their families), the community level (schools and neighbourhoods), and regional/national/international level (governments).

**Prevention of child obesity.** Intervention programmes targeting the obesity-related lifestyle risk factors of diet, physical activity and sedentary behaviour were shown to have beneficial effects on children's BMI, particularly in children aged 6-12 years (Waters et al., 2011). This conclusion was drawn based on a recent high-quality meta-analysis (Cochrane Review) including 37 studies (Waters et al., 2011). The overall intervention effect was a reduction of BMI by  $0.15 \text{ kg/m}^2$  (95% CI -0.21 to -0.09,  $P < 0.001$ ) in 15,489 children. The combined effect of studies that employed both dietary and physical activity interventions on BMI was greatest compared to diet or physical activity interventions alone (Waters et al., 2011). Waters et al. (2011) concluded that obesity prevention programmes can be most effective when implemented in the school setting with parental involvement. The Scottish clinical guideline for prevention of obesity in children and young people (SIGN 115) therefore recommends as follows:

*“Sustainable school based interventions to prevent overweight and obesity should be considered by and across agencies. Parental/family involvement should be actively facilitated.”* (page 40) (SIGN, 2010).

Dietary interventions aiming to increase fruit and vegetable intake, to promote water consumption, to improve school meals and to reduce intake of sugar-sweetened beverages were shown to have beneficial effects in preventing child and youth obesity (SIGN, 2010). There are no specific physical activity and sedentary behaviour recommendations for the prevention of overweight and obesity in children. However, clinical guidelines refer to the recommendations for the general population (NICE, 2006). That is; children aged 5 years and older should be physically active in moderate intensity for 60 minutes per day (WHO, 2010). Younger children up to the age of 5 years should engage daily in light physical activity for three hours (BHFNC, 2011).

Findings from another systematic review of 15 studies (6423 participants) targeting both school and home environment suggested that studies employing behaviour change techniques appeared to be most effective in terms of improving diet and physical activity levels and reducing sedentary behaviour (Hendrie et al., 2012). Behaviour change techniques used in those obesity prevention studies which were effective were provision of information, prompting practice and planning for social support (Hendrie et al., 2012).

Individual and community level interventions alone are not sufficient for preventing childhood obesity and to reverse the high prevalence of obesity at a young age (Gortmaker et al., 2011). Multilevel initiatives with involvement of governments are required. In 2012 the WHO published a report entitled “Prioritizing areas for action in the field of population-based prevention of childhood obesity: a set of tools for Member States to determine and identify priority areas for action.” in which essential sectors and setting were described for successful childhood obesity prevention on the government level (WHO, 2012). The sectors are grouped into the following policy action points:

- Socio-ecological policies which should target, for example, agriculture, food processing, food marketing, infrastructure, transport and education
- Lifestyle behaviour policies which should aim to improve diet and physical activity patterns through social marketing, education and motivation initiatives
- Health service policies that should support health services and clinical interventions.

Additionally, governments could act through food and beverage tax systems and implementation of laws and regulations (e.g. food marketing) to prevent child and youth obesity. An European example for a coordinated multilevel childhood obesity prevention approach is EPODE ('Ensemble Prévenons l'Obésité Des Enfants', Together Let's Prevent Childhood Obesity). Implemented in 2004, currently more than 500 communities in six countries are following the EPODE approach (Borys et al., 2012).

**Treatment of child obesity.** Findings of a systematic review and meta-analysis (Cochrane Review) including 64 randomised controlled trials of 5,230 children indicated that behavioural lifestyle interventions aiming to alter eating and sedentary behaviour and physical activity pattern in a family-based setting were effective in achieving clinically meaningful (BMI Standard deviation score (SDS) reduction  $> 0.25$ ) weight reduction (Oude Luttikhuis et al., 2009).

As for the prevention of childhood obesity, an additional effective component of a comprehensive lifestyle intervention to treat childhood obesity is the use of behavioural change techniques including self-monitoring, goal setting, stimulus control, problem solving and reward for reaching goals (NICE, 2006).

Sargent et al. (2011) conducted a systematic review on the effect of obesity treatment interventions in a primary care setting including general or family practice, health centres and hospital outpatient clinics (Sargent et al., 2011). Results from 17 reviewed randomised and non-randomised intervention studies of 3,068 overweight

or obese children and adolescents indicated that 12 of the 17 studies showed significant beneficial effects on obesity indices (BMI, body fat), metabolic markers, energy intake, diet quality, and physical activity levels. Evidence suggested that significant positive changes in lifestyle behaviour might be achieved in short, low-intensity interventions of one contact per month or less when effective techniques are used such as motivational interviewing (Sargent et al., 2011). More intense lifestyle interventions (physical activity, diet, sedentary behaviour) with a higher frequency (at least once per week) and amount of sessions are required for clinically significant beneficial changes in obesity indices and metabolic markers (Sargent et al., 2011).

Therefore, current clinical guidelines incorporate these strategies into their recommendation for treatment of child and youth obesity (NICE, 2006, 2013; SIGN, 2010). They further recommend:

*“Programmes should target decreasing overall dietary energy intake, increasing levels of physical activity and decreasing time spent in sedentary behaviours (screen time).”* (page 42) (SIGN, 2010).

As for prevention of child and youth obesity, no specific recommendations on physical activity for treatment of obesity exist to date and practitioners are referred to recommendations for the general paediatric population (SIGN, 2010). For decreasing sedentary behaviour, it is recommended to reduce screen time (TV viewing, computer and video games) to less than two hours per day (SIGN, 2010).

For severely obese adolescents (BMI 99.6<sup>th</sup> centile relative to the 1990 UK reference population) the Scottish guideline for management of obesity (SIGN 115) recommends the use of pharmacological treatment (Orlistat) in conjunction with lifestyle interventions (SIGN, 2010). The evidence on the effectiveness of pharmacological treatment when used alone is not convincing. Only minor weight loss was achieved without maintenance in the long-term (Hsia et al., 2012). Surgical management may be offered to severely obese adolescents with existing co-morbidities who did not achieve health improving weight loss through lifestyle

interventions. Psychological evaluation prior to such bariatric surgery is required to assess potential risk factors and to determine treatment success (Hsia et al., 2012).

**Obesity prevention and treatment policies in Scotland.** The high prevalence of childhood obesity in Scotland motivated the Scottish Government to develop policies in relation to healthy eating and physical activity for prevention and treatment of obesity in Scotland. The first policy aimed at the reduction of an overweight population in Scotland was published in 2008 and is called '*Healthy Eating, Active Living: An action plan to improve diet, increase physical activity and tackle obesity (2008-2010)*' (The Scottish Government, 2008). As part of this policy the initiative '*Child Healthy Weight Interventions*' were implemented specifically targeting the prevention and treatment of childhood obesity for children aged 2-15 years. In 2010 another policy followed named '*Preventing overweight and obesity in Scotland: A route map towards healthy weight*' (The Scottish Government, 2010b). Aiming at governmental decision-makers, this policy document stated as one of their primary targets to "reduce the rate of increase in the proportion of children with their Body Mass Index outwith a healthy range by 2018" (page 2).

School context specific policies aim at general health promotion which may impact on the prevention and treatment of childhood obesity indirectly. Under the '*Schools (Health Promotion and Nutrition) (Scotland) Act 2007*', schools are encouraged to promote health and healthy nutrition in particular (The Scottish Government, 2007). This involved introducing food and beverage standards for breakfast services, tuck shops, vending machines and after-school clubs as well as promotion of school lunches and provision of free school meals. Closely related to the '*School (Health Promotion and Nutrition) (Scotland) Act 2007*' is the school subject 'Health and Wellbeing' within the Curriculum for Excellence which was implemented in 2010. Through learning in Health and Wellbeing all children in Scotland "develop the knowledge and understanding, skills, capabilities and attributes which they need for mental, emotional, social and physical wellbeing now and in the future." (The Scottish Government, 2010a).

In conclusion, for prevention and treatment of childhood obesity on an individual/family and community level, a multi-disciplinary approach consisting of medical professionals, dietitians/nutritionists, exercise experts (physiotherapist, physical education teachers, and sport scientists), psychologists, and family members is required. Tackling childhood obesity across the population calls for changing the obesogenic environment which needs comprehensive policy approaches aimed at the food industry (e.g. food labelling, taxes, advertisement, retailer outlets), school environment (e.g. meals, vending machines, health education, physical education/physical activity) and build environment (e.g. transport, neighbourhood safety) (Gortmaker et al., 2011; Swinburn et al., 2011). Policies that promote change in “social norms and create optimal defaults where the default option is the healthy choice, and thus facilitating and reinforcing individual behaviour change” (McKinnon, 2009) might be the solution to tackle the childhood obesity pandemic.

### **1.3. Aim**

Childhood overweight and obesity are highly prevalent, associated with severe health consequences and may be a risk factor for poor educational attainment. However, an up-to-date in-depth synthesis of the available literature on the association between childhood obesity and educational attainment is lacking. Furthermore, since lifestyle change interventions are recommended in clinical guidelines to treat childhood obesity, there might be an additional beneficial effect of these interventions on educational outcomes. Evidence of this potential beneficial outcome of lifestyle interventions has not been systematically explored to date.

Therefore, the overall aim of this thesis was to assess the effect of lifestyle interventions on educational attainment in overweight and obese children and adolescents. Throughout this thesis educational attainment relates to knowledge and understanding in specific school subjects, obtained during the course of formal education; either individual school subjects or average attainment for one school year in the form of grades or test scores.

For the development of interventions involving action on more than one level (e.g. individual, family, community) and more than one (lifestyle) intervention component



(e.g. nutrition, physical activity) the Medical Research Council (MRC) recommended a five stage approach (Campbell et al., 2000). The five stages comprise:

1. Synthesis of evidence from observational and experimental research (Theory),
2. Identification of effective intervention components and underlying mechanisms (Modelling),
3. Establishment of feasibility and preliminary effects (Explorative trial),
4. Conduct of a definite randomised controlled trial,
5. Implementation of long-term interventions and process evaluation (Campbell et al., 2000).

The five stage approach represents a research framework which is made of three columns; establishment of the rationale of potential intervention effects (stages 1 and 2), establishment of the efficacy of interventions (stages 3 and 4), and establishment of the effectiveness of interventions (stage 5).

This doctoral research covered the stages one to three of the complex intervention framework.

## **1.4. Thesis structure**

After setting the general context of the thesis topic, the following chapters describe the research conducted to address the overall thesis aim. I conducted three studies with distinctive study designs which are presented in Chapter 3 to Chapter 5.

In Chapter 2, I synthesise the evidence from cross-sectional and longitudinal studies on the association between childhood obesity and educational attainment, cognitive function, and later life achievements. In Chapter 2, I also discuss the available body of literature on how lifestyle interventions might work to influence cognitive function and educational attainment in the general population and in overweight and obese children and adolescents. Therefore, Chapter 2 develops a

rationale to why lifestyle interventions in overweight and obese children might improve educational attainment and associated achievements.

The evidence on experimental lifestyle intervention trials to improve cognitive, educational and later life outcomes in overweight and obese children is empirically assessed in Chapter 3 (study 1). This allowed an opportunity to evaluate the efficacy of lifestyle interventions for improvement of educational attainment and associated outcomes in overweight and obese children.

Findings of Chapter 3 informed the second study outlined and discussed in Chapter 4. Study 2 established the feasibility of definitive studies examining the effectiveness of lifestyle interventions in overweight and obese children on educational outcomes using administrative data. Findings of study 2 also comprise a pilot study to assess the effectiveness of a Scottish primary care child weight management intervention on participants' educational attainment.

Experiences and perceptions of participants of any intervention, and lifestyle interventions in particular, are critical to evaluate the feasibility of interventions and the development of effective programmes. Therefore, in Chapter 5, I describe the rationale, methodology, and findings of a focus group and interview study (study 3) which aimed to gain an insight into body weight related school experiences of overweight and obese adolescents who participated in a weight management programme.

Finally, in Chapter 6 I discuss the findings from all three studies and provide an overall thesis conclusion.

## **1.5. Method of inquiry**

A mixed-method approach was used to address the above listed research aim. Mixed method research is defined as the combination of qualitative and quantitative research paradigms in terms of viewpoints, data collection methods, and/or data analysis methods. Integrating both research paradigms allowed an opportunity to better address the research aims, comprehensively in both breadth and depth. Findings can then be validated from the other research paradigm, thus potential weaknesses of research designs can be counteracted, which provides a greater

confidence in the conclusions drawn and provides a deeper understanding of the overall findings (Johnson et al., 2007b).

There are two mixed method research designs; the mixed-model and mixed methods design. The method used in this thesis is the mixed-model method where quantitative and qualitative approaches were used across different stages of the research process opposed to including a qualitative and quantitative phase in an overall study (Johnson & Onwuegbuzie, 2004). Since the first two studies rely primarily on the quantitative research paradigm, overall my doctoral research followed a quantitative dominant mixed method research design. The qualitative approach in study 3 is understood to complement findings of study 1 and 2 and therefore to benefit the overall research.

The philosophical assumption underlying the present research is pragmatism; an assumption that is not committed to one philosophical reality (Creswell, 2012). It allows combining philosophical positions of both qualitative and quantitative research and is therefore a suitable approach when using mixed methods (Creswell, 2012; Johnson & Onwuegbuzie, 2004). Pragmatism is a practical and outcome-oriented method focussing on action, situations and consequences. Hence, pragmatist research investigates what works and how it works. This method of inquiry leads to further action (i.e. development of new research questions) instead of concentrating on definite solutions (Johnson & Onwuegbuzie, 2004).

## CHAPTER 2: Literature Review

### **Aims and objectives:**

To develop the rationale for why lifestyle interventions might improve educational attainment and associated outcomes in overweight and obese children by synthesising the evidence

- Of observational studies on the association between childhood obesity and educational attainment, cognitive function and future success
- Of observational and experimental studies on the effect of lifestyle intervention on educational attainment and cognitive function in the general population

As indicated in the previous chapter, the literature acknowledges a link between child health and education. Systematic research evidence suggests that childhood obesity is negatively associated with educational attainment and cognitive function. In this chapter I provide a critical literature review of the existing published literature on childhood obesity and educational attainment in two parts. In the first part I critically reviewed the literature on the associations between childhood obesity and educational attainment, cognitive function and future success. Part one concludes with reviewing potential confounders and mediators of the obesity-attainment association. In the second part I summarise and assess the existing literature on how lifestyle interventions might work for improving educational attainment and associated achievements.

### **2.1. Association between childhood obesity and educational attainment (Systematic review)**

There are two previous literature reviews on this topic. Firstly, Taras and Potts-Datema (2005) reviewed only nine studies restricted to adolescents (n=106,267) in a non-systematic fashion (Taras & Potts-Datema, 2005). Secondly, Caird and colleagues (2011) systematically reviewed 29 cross-sectional and longitudinal studies including 259 to 60,252 children and youth published up to 2009 (Caird et al.,

2011). Despite conflicting evidence, researchers concluded that there is a weak direct association between childhood obesity and educational attainment; overweight and obese children typically perform less well in school compared to normal weight peers. When other factors associated with obesity and educational attainment, such as socio-economic status, ethnicity, gender and age were taken into consideration, the association weakened further. There might be an indirect link between child obesity and educational attainment, and obesity might be a marker rather than a direct causal factor. In an attempt to explore the causality four of the 29 studies assessed changes in body weight status over time and its relationship to educational attainment (Caird et al., 2011). Although all four studies used data from the Early Childhood Longitudinal Study-Kindergarten Cohort (ECLS-K), findings are not fully consistent but indicated in general that children who became overweight between the 1<sup>st</sup> and the 3<sup>rd</sup> grade obtained lower attainment scores compared to children who were never obese (Caird et al., 2011). Since Caird et al. (2011) conducted the systematic literature search; more evidence on the obesity-attainment association has emerged.

Therefore, the aim of the present systematic review was to evaluate the most recent evidence on the association of childhood obesity and school achievement following on from Caird et al's systematic review and to re-evaluate existing literature to date.

## **Methods**

*Search methods.* The electronic databases Medline (ovid), Embase (ovid), PsycINFO (ovid), Education Resource Information Centre (ERIC), Social Science Citation Index, Arts & Humanities Citation Index and SportDiscus were searched (December 2012) combining the terms child\*, youth, adolesc\*, obes\*, overweight, school, academic, education\*, achievement, performance, and attainment. The search strategy for Medline, Embase and PsycINFO was:

1. exp child/
2. exp youth/
- 3.youth.tw.
4. exp adolescent/
5. adolesc\*.tw.
6. child\*.tw.
7. 1 or 2 or 3 or 4 or 5 or 6
8. obes\*.tw.
9. exp overweight/
10. overweight.tw.
11. adiposity.tw.
12. 8 or 9 or 10 or 11
13. ((school or academic\* or education\*) adj2 (attainment or performance or achievement)).tw.
14. exp school/
15. exp education/
16. 7 and 12 and 13
17. limit 16 to yr="2008 -Current".

The date of publication was limited from 2008 to current to create an overlap to Caird et al's (2011) systematic review search and therefore to allow for capturing articles that were later indexed by electronic databases and thus not included in the previous systematic review. Additionally, I screened reference lists of potentially relevant studies, identified studies through forward citations of potentially relevant studies, and consulted experts in the field.

*Selection criteria.* Studies were included when they met all of the following inclusion criteria:

- Cross-sectional, longitudinal cohort or case-control studies.
- Healthy participants aged 3 to 18 years (i.e. absence of conditions that are associated with overweight/obesity and impaired school performance).
- Studies that obtained measures or estimates (i.e. self-reported) of body weight status as either BMI, BMI percentiles, BMI z-scores, body fat, body fat percentage or waist circumference.
- Studies that provided measures or estimates of academic achievement limited to overall school performance and/or specific subject performance obtained through either standardised tests, teacher reports or self-reports.
- Studies published as full text in English or German language.

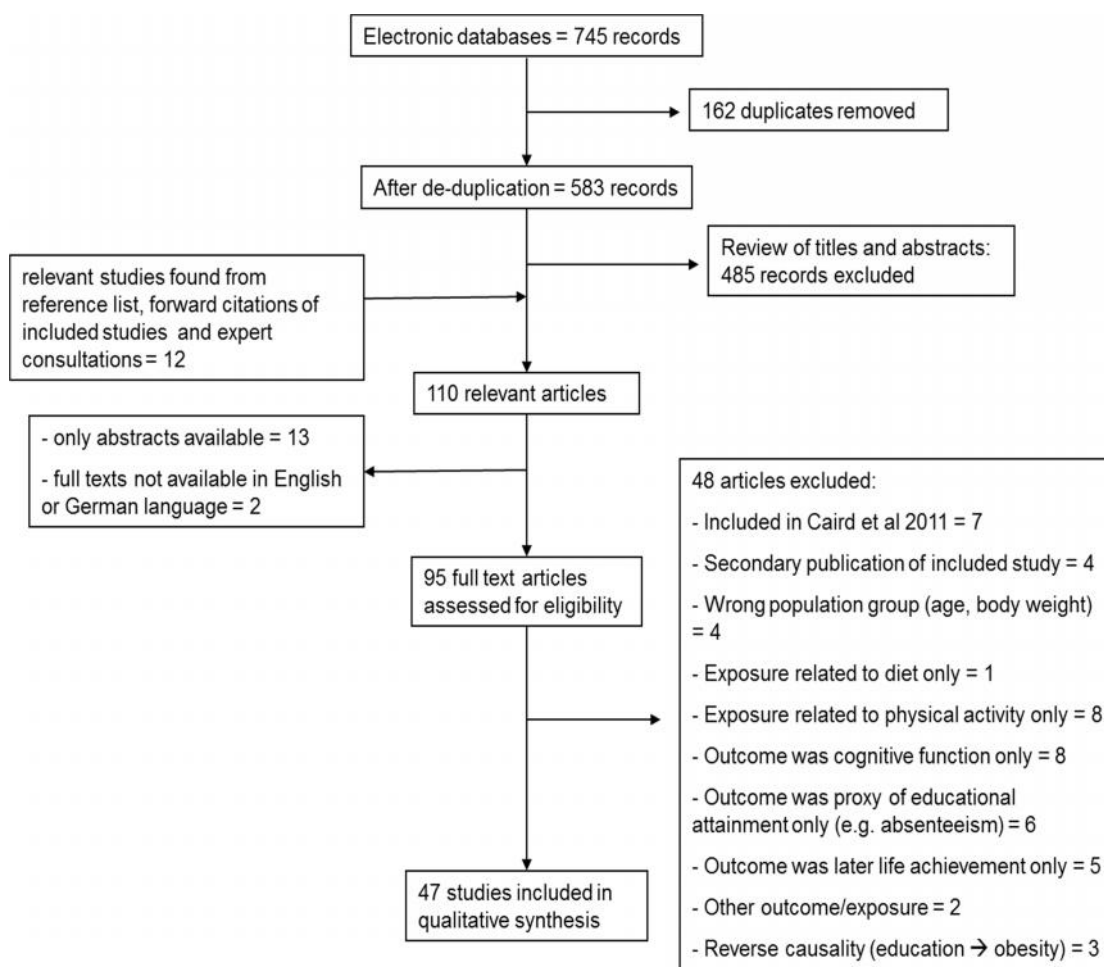
*Data extraction.* The following predefined data items were extracted from included studies: Country, study design, sampling methods, sample size, participant characteristics, measure of adiposity (type, method, and overweight/obesity cut-off criterion/reference population), measures of educational attainment, confounding and mediating variables, statistical analysis methods, and results. Results were qualitatively synthesised.

*Quality assessment.* Quality assessment was informed by criteria proposed in the literature (Caird et al., 2011; Shamliyan et al., 2011). The quality of studies and thus the strength of findings were assessed based on five quality criteria: sample size of at least 1000 participants, random or representative sampling strategy, objective measurement of body weight status and educational attainment, and controlling for confounders and mediating variables. Quality assessment is presented as proportion of studies meeting the quality criteria relative to the direction of the obesity-attainment association.

## **Results**

The literature search (Figure 2.1) generated 747 records including 162 duplicates. After screening titles and abstracts 485 irrelevant records were excluded leaving 105

potentially relevant. Of these, 13 had no available full text and 2 had no English or German language version. Eleven studies were found from screening reference lists and checking forward citations of included studies. One study was identified through expert consultation. Eligibility criteria applied to 95 full-text articles led to the inclusion of 47 studies (N = 638,136) and exclusion of 48 studies. Reasons for exclusions are listed in Figure 2.1.



**Figure 2.1: PRISMA diagram of search results and selection of included studies**

**Characteristics of included studies.** Characteristics of included studies not reviewed in the previous literature can be found in Tables 2.3 and 2.4 according to the nature of study design. Cross-sectional studies are summarised in Table 2.3 and longitudinal studies in Table 2.4.



*Study design and population.* Forty cross-sectional and seven longitudinal studies conducted in a range of countries were included; more than half of the studies (29/47) took place in North America (Table 2.3 and 2.4). Sample sizes ranged from 35 to 254,743 participants. Twenty-seven studies were carried out in primary school-age children (4-13 years), eight in secondary school-age children, and the remaining studies included children from both age groups. The gender distribution was similar in most (42/47) studies (median 49.8% girls). The follow-up length of the longitudinal studies was two years (Telford et al., 2012), 4 years (Veldwijk et al., 2012), 5 years (Booth et al., 2014), 5.5 years (Gable et al., 2012; Li & O'Connell, 2012), and 6 years (Carter et al., 2010; Chen et al., 2012).

*Assessment of obesity status.* All but two studies assessed children's weight and height for calculating BMI. A variety of obesity indices based on BMI was used; most studies (26/43) assessed body weight status by referring to age and gender specific BMI reference growth charts percentiles (Cole et al., 1995; Khang & Park, 2011; Kromeyer-Hauschild et al., 2001; Kuczmarski & Flegal, 2000). Nine studies defined overweight and obesity by using international (IOTF) age and gender specific BMI cut-offs (Cole et al., 2000). Two studies assessed body fat exclusively (Telford et al., 2012; Von Hinke Kessler Scholder et al., 2012) and eight studies used both BMI cut-offs and body fat assessment (Barrigas & Fragoso, 2012; Davis & Cooper, 2011; Du Toit et al., 2011; Kafyulilo, 2008; Kamijo et al., 2012a; LeBlanc et al., 2012; Padilla-Moledo et al., 2012; Ramaswamy et al., 2010). The methods used to determine child's total body fat were measuring skinfold thickness (Barrigas & Fragoso, 2012; Du Toit et al., 2011; Kafyulilo, 2008; Padilla-Moledo et al., 2012), and using dual-energy x-ray absorptiometry (DEXA) (Davis & Cooper, 2011; Kamijo et al., 2012a; Telford et al., 2012; Von Hinke Kessler Scholder et al., 2012)) and bioelectric impedance analysis (BIA) (LeBlanc et al., 2012; Ramaswamy et al., 2010).

*Assessment of educational attainment.* More than half of the studies (32/47) administered standardised tests of educational attainment including national tests

(eight studies), regional (US states) tests (seven studies) and different test batteries for educational attainment (16 studies). Nine studies relied on self-reported or parent-reported measures of academic performance and eight studies used teacher reported attainment scores obtained from school records (Table 2.3 and 2.4). Twenty-four studies assessed overall school performance; the remaining studies investigated the association between childhood overweight/obesity and specific subject attainment. The subjects included mathematics, reading, writing, spelling, language skills, social science, and science.

**Association between childhood obesity and educational attainment.** Findings of all published studies on the association between childhood obesity and educational attainment, including studies which were previously reviewed, are listed in Table 2.2 by direction and impact of the obesity-achievement association.

In total, 37 studies suggested a negative association between child obesity and educational attainment for some subjects of which six studies were prospective cohort studies. Twenty-seven studies (including six longitudinal studies) indicated a negative trend meaning that the negative relationship became non-significant after controlling for confounding and mediating variables. No relationship was detected by 29 studies including seven longitudinal studies. Five studies suggested a positive association and four studies indicated a positive trend of which one study was of longitudinal nature.

*Evidence from cross-sectional studies.* Table 2.1 gives an overview of the effect sizes of studies which used objective educational attainment measures and controlled for confounders or mediators.

Cross-sectional evidence suggested that, compared to normal weight, overweight or obesity is associated with lower attainment scores by 3.97 to 1.83 points on a scale with a mean of 100 and SD of 15 (Averett and Stifel, 2010, Kaestner and Grossman, 2009, Palermo and Dowd, 2012) and by 0.25 points (scale range 0-4) (Sabia, 2007) compared to normal weight peers. Compared to normal weight children, obese children were 1.4 times more likely to obtain poor attainment scores (Florence et al., 2008) and had a 3% increased risk of failing attainment tests

(Perez-Chada et al., 2009). One unit increase in BMI was associated with a reduction in attainment scores by 1.8 points on a scale ranging from 0 to 400 (Castelli et al., 2007), by up to 0.3 points on a scale with a mean of 100 and SD of 15 (Kamijo et al., 2012a), and by 18.5 points on a scale ranging from 0 to 100 (Cho et al., 2009). Only a few studies reported the variation in educational attainment attributable to overweight or obesity. Von Hinke Kessler Scholder et al. (2012) reported that only 2% of the variation of educational attainment at 14 years is explained by fat mass at 11 years. The variability of attainment scores at 11 years is attributable to fat mass at 9 years by only 1% (Von Hinke Kessler Scholder et al., 2012). Similarly low variability was detected by Kamijo et al. (2012). Researchers indicated that increased BMI explained 2% of lower reading scores, 4% of lower spelling scores, and 6% of lower mathematics scores. Considering percentage body fat, Kamijo and colleagues suggested that only 3% of the variability of reading and spelling was explained by increased percentage body fat (Kamijo et al., 2012a). Averett and Stifel (2010) indicated that overweight in black boys explained 12% variation in reading; overweight in white girls explained 14% of variation in math scores, and 3% of variation in mathematics and reading scores was attributable to being overweight in white boys (Averett & Stifel, 2010). Similar results were found by Li and O'Connell; 16% of the variation in reading performance and 12% of mathematics performance was explained by being obese.

However, some studies (N = 12) reported that a negative association was restricted to a certain population group, adiposity or attainment measures. Averett and Stiefel (2010) reported a significantly negative association between overweight and mathematics attainment while there was no evidence of an inverse relationship for reading attainment. Gurley-Calvez and Higginbotham (2010) on the other hand, suggested a negative association between reading attainment and obesity in children of low socio-economic status but not for mathematics attainment. Kaestner and Grossman's (2009) findings indicated lower reading comprehension scores in obese girls compared to normal weight peers but no association was found for mathematics attainment in girls. For boys, researchers reported a positive association (Kaestner & Grossman, 2009). Palermo and Dowd (2012) restricted this finding even further indicating that a significantly negative relationship for reading scores is only present

in obese white girls but not for obese black or Hispanic girls. Researchers also found no evidence of an association between reading attainment and obesity in boys (Palermo & Dowd, 2012). In contrast, Shore et al. (2008) identified that a significantly negative association between obesity and reading attainment weakened after adjusting for confounding variables. However, the association remained statistically significant for a negative relationship between obesity and average attainment scores (Shore et al., 2008). The gender difference in the obesity-attainment association was also confirmed by Ding et al. (2009). After controlling for confounding and mediating factors the negative association remained significant only for girls. Sabia (2007) used GPA scores in mathematics and English/language arts as dependent variables and found that obese non-white adolescent boys and girls obtained lower grades but not obese white girls and boys after controlling for confounding and mediating variables (Sabia, 2007). Von Hinke Kessler Scholder et al. (2012) assessed the association between fat mass and average grades in English, mathematics and science indicating a significantly negative association between fat mass and attainment at age 11 years but not age 9 years, after controlling for confounders.

Five studies suggested that overweight or obesity is significantly positively associated with educational attainment; that is overweight or obese children and adolescents perform better in school compared to normal weight peers. Two of those studies performed only correlation analyses without controlling for confounding and mediating variables. Researchers reported weak positive pairwise correlations between fat mass and average scores in mathematics, reading, and writing ( $r = 0.06$ ) at age 7 years (Gregg et al., 2008) and between BMI and average attainment scores ( $r = 0.24$ ) in children aged 7-17 years (Welk et al., 2010). The remaining three studies used multivariate regression models adjusting for a number of confounders/mediators including age, ethnicity, and socioeconomic status. However, all studies used self-reported BMI measures. Chowdhury et al. (2008) suggested a significantly positive association between obesity and reading scores in boys whereas the association for reading scores in overweight girls showed a negative trend. Eide et al. (2010) also found a significantly positive association between overweight and reading scores in

boys but also in girls. A gender difference was reported for mathematics scores suggesting a positive association in overweight boys but not girls (Eide et al., 2010). Pesa et al. (2000) studied girls only and their findings indicated, based on self-reported grades in English, mathematics, science, and history, that overweight adolescent girls (15-17 years) outperformed normal weight peers (N = 3,197) (Pesa et al., 2000).

**Table 2.1: Regression coefficients and effect sizes of attainment scores from regression models (random effects) of cross-sectional studies with objectively assessed attainment measures**

<b>Reference</b>	<b>Sample Size</b>	<b>School subject</b>	<b>Regression coefficients</b> (standard errors in parathesis where available)	<b>Standardised effect sizes</b> ( $R^2$ , otherwise stated)
Averett and Stifel, 2010	N = 2,966 - 4,563	Mathematics	-1.85 to – 2.10 (0.17) points in overweight girls and -1.48 to -1.93 (0.17) points in overweight boys (scale mean 100, SD 15)	0.17 in overweight girls and 0.14-0.17 in overweight boys
Castelli et al., 2007	N = 582	Average attainment	-1.8 (0.63) points with one unit increase in BMI (scale 0-400);	0.02
		Reading	-0.83 (0.31) points with one unit increase in BMI (scale 0-400)	0.02
Cho et al., 2009	N = 1,346	Average of English, Korean, Mathematics	-18.5 points with one unit increase in BMI (scale mean 100, SD 20)	0.21
Eide et al., 2010	N = 1,282	Mathematics	0.13 SD in overweight boys compared to normal weight children	Not reported

Table 2.1 (continued)

<b>Reference</b>	<b>Sample Size</b>	<b>School subject</b>	<b>Regression coefficients</b> (standard errors in parathesis where available)	<b>Standardised effect sizes (<math>R^2</math>)</b>
Florence et al., 2008	N = 4,589	Reading and Writing	OR 1.41 (95% CI 1.10-1.81) of poor school performance in obese children compared to normal weight peers	OR 1.41 (95% CI 1.10-1.81) of poor school performance in obese children compared to normal weight peers
Gurley-Calvey and Higginbotham, 2010	N = 272	Reading	-0.10 (0.45) % point with one % point increase in obesity	0.49
Han 2012	N = 2,153	Reading	-0.15 SD points (0.05) in obese girls	Not reported
Kaestner and Grossman, 2008	N = 2,146	Reading	-1.83 (0.76) scores in obese compared to normal weight peers (11-12y); 1.51 (0.72) scores in obese compared to normal weight peers (7-8y) (scale mean 100, SD 15)	Not reported
Kamijo et al., 2012	N = 126	Reading, Spelling, Mathematics	-0.21 to -0.28 SD points with increasing adiposity measure (BMI, BMI z-score, %BF)	0.02-0.06
Kantomaa et al., 2013	N = 8,061	Average attainment	-0.09 (0.02) SD scores in obese children	0.31

Table 2.1 (continued)

<b>Reference</b>	<b>Sample Size</b>	<b>School subject</b>	<b>Regression coefficients</b> (standard errors in parathesis where available)	<b>Standardised effect sizes (<math>R^2</math>)</b>
Palermo and Dowd, 2012	N = 1,184	Reading	- 1.93 (0.97) points in obese girls compared to normal weight peers (scale mean 100, SD 15)	0.20
Perez-Chada et al., 2009	N = 2,210	Mathematics	0.03 increased odds to fail attainment test in obese children	OR 1.03 (95%CI 1.01 – 1.06)
Sabia 2007	N = 1,055 (boys) N = 1,472 (girls)	Average attainment	-0.25 (0.42) points in obese boys and -0.29 (0.10) in obese girls compared to non-obese peers (scale 0-4)	Not reported
Von Hinke Kessler Scholder et al. 2012	N = 2,846	Average in Mathematics, English, Science	One SD increase in fat mass associated with 4% (1%) decrease in test scores (mean 100, SD 10)	0.32

*Evidence from prospective cohort studies.* For assessment of the direction of the association in relation to changes over time and interferences to the causality of the obesity-attainment association findings of prospective longitudinal studies are required. Overall, to date, the prospective relationship between childhood obesity and school achievement was evaluated in 11 studies. Five of the eleven studies performed secondary data analyses of the Early Childhood Longitudinal Study – Kindergarten Class (ECLS-K) (Datar & Sturm, 2006; Datar et al., 2004; Gable et al., 2008; Gable et al., 2012; Wendt, 2009). Other datasets used for secondary data analyses were the National Longitudinal Survey of Children and Youth (Carter et al., 2010) the Avon

Longitudinal Study of Parents and Children (Booth et al., 2014), and the Prevention and Incidence of Asthma and Mite Allergy (PIAMA) birth cohort (Veldwijk et al., 2012). Chen et al. (2012), Mo-Suwan et al. (1999), and Telford et al. (2012) used primary data for their prospective analyses. The number of participants ranged from 405 to approximately 14,000 and the follow-up periods ranged from two to six years.

Mo-Suwan et al. (1999) reported that adolescents aged 13-15 years ( $N = 587$ ) who became overweight over the course of two years and those who were persistently overweight obtained significantly lower attainment test scores compared to normal weight children controlling for parental education, occupation and income (Mo-suwan et al., 1999). However, there was no evidence of an inverse association for younger children aged 8-13 years ( $N = 1,207$ ). Similar, Veldwijk et al. (2012) stated that, after controlling for parental education, breakfast skipping, and screen time, the negative relationship between overweight and educational attainment scores was no longer significant for children who were persistently overweight between 8 and 12 years of age. For children who became overweight, there was no significant relationship with lower attainment scores even in the unadjusted analysis (Veldwijk et al., 2012). Datar and Sturm (2006) suggested a significantly negative association between obesity and mathematics and reading attainment for girls aged 9 years who became overweight within four years, after adjusting for socio-economic status, prior attainment and lifestyle factors. The negative association weakened for persistently overweight girls in relation to mathematics attainment and for newly or persistently overweight boys for both subjects after controlling for confounding variables. Researchers also noted that being persistently obese positively influenced reading scores in girls (Datar & Sturm, 2006). In contrast, using the same dataset, employing multilevel modelling and adjusting for gender, ethnicity and socio-economic status in 8,000 children, Gable et al. (2008) reported that children who were persistently overweight obtained lower mathematics and reading scores compared to children who were never overweight during the study period of four years (Gable et al., 2008). More recent analyses of ECLS-K data by Gable et al. (2012) including psychological and behavioural covariates confirmed previous findings on mathematics attainment in 6,250 children. They also found that children who became overweight scored lower in mathematics tests compared to children who were never



overweight (Gable et al., 2012). These findings were also confirmed by Wendt (2009) who used the same dataset as Datar and Sturm (2006) and Gable et al. (2008, 2012). Including 14,000 children and controlling for 20 covariates including, for example, socio-economic status, gender and age, Wendt (2009) indicated a significantly negative association between mathematics attainment and overweight regardless of whether the body weight status changed over time or not. There were no indications of a negative association of changes of obesity over time and reading attainment (Wendt, 2009). Using data from the National Longitudinal Survey of Children and Youth of 2,582 children aged 8-11 years at follow-up (6 years), Carter et al. (2010) found no evidence of an association between mathematics attainment and developing obesity and being persistently obese. However, a significantly negative association was detected for vocabulary scores in persistently obese compared to never-obese children. Moreover, Carter et al. (2010) suggested that children who lost weight during the study period had significantly higher mathematics scores compared to children who were never obese (Carter et al., 2010). Most recently, Booth and colleagues (2014) studied 4,260 British children over a 5 year period. They reported that persistently overweight and obese girls (age 11 years to 16 years) obtained lower English, mathematics and science grades compared to never-overweight/obese peers after adjusting for 14 confounding and mediating variables (e.g. SES, child's IQ, physical activity level). The researchers also suggested that girls who gained weight and moved from being overweight to being obese had lower attainment grades compared to never-overweight/obese peers. There was no significant negative association between school achievement and weight status change in boys in general, and in girls who developed overweight or obesity and who obtained a healthy body weight status over the follow-up period (Booth et al., 2014). Finally, findings from a two-year prospective cohort study in 757 Australian children aged 10.5 years at follow-up suggested no association between mathematics, reading and writing scores and percentage body fat, applying multilevel modelling and controlling for socio-economic status (Telford et al., 2012). Similarly, there was no statistically significant evidence of a negative association between change in body weight status and average educational attainment in five subjects including mathematics after controlling for school absenteeism, IQ, parental

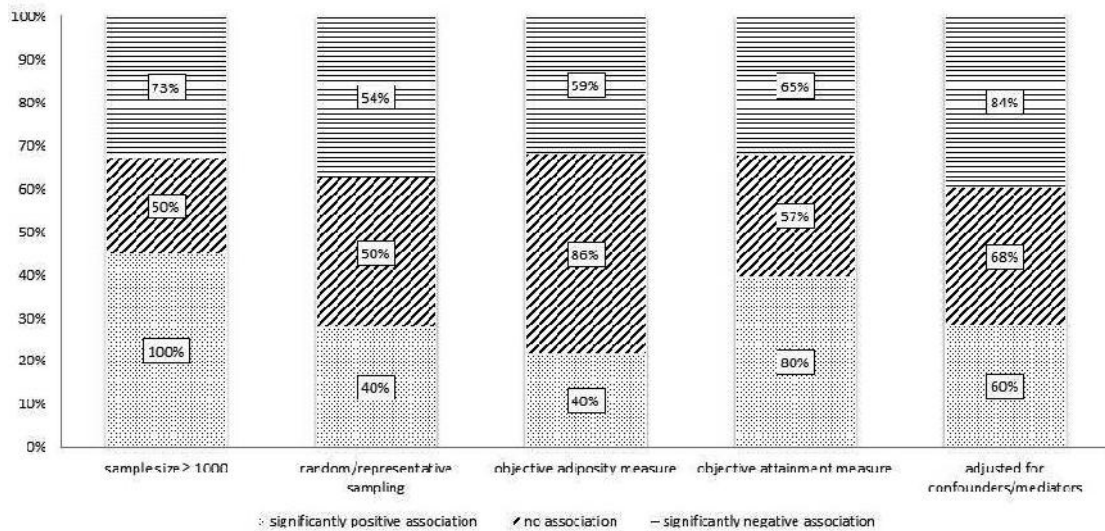
education, gender and family characteristics in 409 Taiwanese first-grade children who were followed for six years (Chen et al., 2012).

**Quality of evidence.** Figure 2.2 displays the proportion of studies which indicated a significant positive association, no association and a significant negative association between childhood obesity and educational attainment for each quality criterion.

More than half of the studies which suggested a positive obesity – attainment association ( $N = 5$ ) obtained attainment measures objectively (80%) and controlled for relevant confounders or mediators (60%) and all studies included at least 1000 participants. However, less than half of the studies ( $N = 2$ ) used objective obesity measures and reported random or representative sampling. None of the five studies met all quality criteria.

For studies which indicated that there was no significant evidence of an obesity-attainment association ( $N = 29$ ), half included at least 1000 children and applied random or representative sampling methods, 86% used objective obesity measures, 57% used objectively obtained school attainment measures, and 68% of the studies adjusted for confounding or mediating variables. Out of 29 studies, seven studies met all quality criteria (25%).

Each quality criterion was met by half or more than half of the studies that showed a negative association between obesity and educational attainment ( $N = 37$ ). A sample size of at least 1000 participants was used by 73% of the studies, 54% reported random or representative sampling, objectively obtained obesity and attainment measures were used by 59% and 65% of the studies, respectively, and the majority of the studies (84%) included confounding or mediating variables in the analysis. Overall, nine studies met all quality criteria (24%).



**Figure 2.2: Proportion (%) of studies meeting quality criteria by direction of the obesity-attainment association.**

Blocks in each column represent the proportion of studies meeting each quality criterion in relation to the number of available studies in each outcome category. Positive association: 5 studies, no association: 29 studies, negative association: 37 studies

## Discussion

The aim of this section of Chapter 2 was to review the literature on the association between child and youth obesity and educational attainment. The systematic literature search included studies published from 2008 until 2013. Studies published before 2008 were previously reviewed and their findings were incorporated in this literature review. The vast majority of studies (67/78) were cross-sectional studies; only 11 prospective cohort studies were available. Overall, 37 studies reported an inverse association between child obesity and school achievement while 29 studies suggested that there is no evidence of an association, and five studies postulated a positive relationship. Out of 78 studies, 27 studies indicated a negative trend and four studies a positive trend.

Across the five quality criteria, the study quality was slightly higher for studies indicating a negative association compared to studies suggesting no significant association. In particular, more than half of the studies which indicated no evidence

of an obesity-attainment association were small scale studies (sample  $N < 1000$ ). A larger sample size increases power and is favourable for producing reliable and robust results. On the other hand, the higher the sample size the more likely it is to detect a significant result only by chance. However, similarly few studies met all quality criteria for studies indicating no association (25%) and a negative association (24%). None of the studies which indicated a positive association met all quality criteria.

Findings from prospective cohort studies may inform of a causal link between childhood obesity and lower educational attainment. Slightly more than half of the prospective cohort studies (6/11 studies) suggested that children who became overweight or obese and children who were persistently obese during the follow up duration of two to six years obtained significantly lower attainment scores than children who were never overweight or obese. Thus, a causal link between obesity and lower educational attainment may be inferred.

A direct causal link might be plausible given that studies demonstrated obesity-dependent changes in brain function associated with cognition and educational attainment. Two potential mechanism of how an increased body weight status in children can directly affect cognition and educational attainment have been proposed to date. First, obesity was shown to be associated with low levels of brain derived neurotrophic factor (BDNF) (Rothman et al., 2012). BDNF is a neurotrophin known to regulate systemic and brain energy metabolism and to be crucial for synaptic plasticity, learning processes and memory (Cowansage et al., 2010). Thus, low levels of BDNF may reduce cognitive and academic abilities. Research investigating the BDNF genotype (which determines BDNF levels in the body) in children and adolescents, indicated that child and youth obesity was significantly associated with variation in the BDNF genotype resulting in lower levels of BDNF compared to normal-weight peers (Skledar et al., 2012). Zhao et al. (2009) also suggested a significant association between BDNF loci and BMI z-scores in 6,078 children (Zhao et al., 2009).

Second, excess adipose tissue is associated with higher levels of leptin which can result in leptin-insensitivity. Recently, neuronal function and cognition was also related to optimal levels of leptin in the brain. To date, it has only been shown in animal models and observational studies in elderly participants, that leptin plays an important role in neurogenesis, synaptic plasticity and learning (Harvey, 2007; Paz-Filho et al., 2010). For example, lower levels of leptin predict dementia in humans (Paz-Filho et al., 2010). Whether childhood obesity impacts on leptin levels in the way that it affects cognitive function and educational attainment is unknown.

Nevertheless, both negative and positive associations were weak and the variability of educational attainment attributable to increased body weight status was low. Therefore, overweight and obesity may influence educational attainment indirectly through mediating variables such as psychosocial factors or ill health. In Chapter 2.4 I discussed potential mediating factors in more detail.

Briefly, plausible mechanisms underlying an indirect negative association between childhood obesity and school achievement relate to psychosocial and pathophysiological mechanisms associated with the development and consequences of childhood obesity outlined in Chapter 1.2.3. Firstly, in comparison to normal weight children and youth, overweight and obese peers experience more frequent psychosocial distress through weight related teasing, discrimination and social isolation, which can result in impaired self-esteem, self-efficacy, quality of life and depression (Brixval et al., 2011; Danielsen et al., 2012; Griffiths et al., 2010; Puhl & Latner, 2007). Overweight-related teasing and social rejection are associated with low school performance in overweight or obese children (Gunnarsdottir et al., 2012a; Krukowski et al., 2009). Secondly, child and youth obesity is associated with co-morbidities such as hypertension, impaired insulin sensitivity, and metabolic syndrome which were shown to be inversely related to cognitive function and educational attainment (Lande et al., 2012; Yau et al., 2012). Health problems may also cause overweight and obese children to miss school more often (Pan et al., 2013); higher levels of school absenteeism are associated with lower performance in school (Gottfried, 2011). Finally, research also indicated that childhood obesity is also associated with sleep deprivation and disrupted sleep due to obesity-related

disordered breathing (Chen et al., 2008). Poor sleep reduces the ability of children to concentrate in school and this in turn impacts negatively on cognitive function and school attainment (Spruyt & Gozal, 2012; Tan et al., 2013).

Synthesis of both cross-sectional and longitudinal studies indicated that the negative association may only be present in subgroups of the overweight and obese child population.

Although not entirely consistent, but suggested by most studies examining gender differences, a negative association between obesity and educational attainment might be stronger in girls than in boys (Booth et al., 2014; Datar & Sturm, 2006; Ding et al., 2009; Du Toit et al., 2011; Palermo & Dowd, 2012; Sabia, 2007). However, a few studies also indicated that overweight among boys was associated with better attainment scores when compared to normal weight peers (Eide et al., 2010; Kaestner & Grossman, 2009). A plausible explanation for the closer association among girls may be that overweight and obese girls face more incidences of stigmatisation than boys (Tang-Peronard & Heitmann, 2008) which may explain lower academic achievement in overweight and obese girls. However, it is well known that in the general population, girls perform, on average, achieve higher attainment scores in school than boys (Deary et al., 2007). Therefore, one could speculate that the true influence of an increased body mass attenuates the gender-attainment relationship and the impact of overweight/obesity on school achievement in girls is underestimated.

In terms of ethnicity, reviewed evidence indicated a trend towards an inverse obesity-attainment relationship in white children but not in non-white or black peers. Some research even suggested a positive association between obesity and educational attainment in black and Hispanic pupils. A possible explanation for this might be that overweight and obese white pupils may be confronted with more weight-related stigmatisation than overweight and obese peers from other ethnic backgrounds due to lower acceptance of an obese body image and lower perceived attractiveness by peers (Ali et al., 2013; Latner et al., 2005).

Based on past literature, ethnicity and gender should be given attention in future research exploring the relationship between weight and academic attainment to examine the extent to which these are important variables.

The evidence on whether childhood obesity is negatively associated with a certain school subject is inconsistent. Moreover, only few studies attempted to investigate the obesity-attainment association for specific school subjects. Since this information may have implications for individual learning support for overweight pupils, future research should assess the association between childhood obesity and specific subject attainment.

This review has methodological limitations. Studies were not selected independently by two researchers and cross-checked due to limited resources and thus relevant literature might have been overlooked and was not included in the review. However, the high number of studies that met the rigorous inclusion criteria and screening of reference lists of included studies reduced the chance of selection bias. We included only English and German language full text articles. This may limit generalizability of results; however, included studies were conducted in various countries including high-, middle, and low-income countries. Independent data extraction was not performed which might have introduced errors. Through predefined data extraction items and discussion of extracted data between authors we attempted to limit this bias. No meta-analysis was included because studies showed major heterogeneity in measures of adiposity and academic achievement. Therefore, a quantitative synthesis of the evidence was entirely appropriate.

## **Conclusion**

Compared to normal-weight peers, child and youth obesity is associated with lower educational attainment. Findings of this systematic review highlight the need for prospective studies with long-term follow-up over primary *and* secondary school age to account not only for stages of brain development but also for obesity related psychosocial factors such as stigmatisation and social isolation that may influence academic achievement later in school. Furthermore, prospective studies will offer greater insight into whether changes in children's weight align with changes in their

academic attainment. Greater emphasis should also be given to evaluate the nature and role of mediating variables and their ability to explain variation in academic achievement, to further explore the relationship between child and youth obesity and low academic achievement. Indeed, these mediating variables may offer insight into individual differences among children and adolescents (i.e., why do some children with obesity issues struggle academically, while others outperform their peers). In addition, greater study into differences in the obesity-attainment relationship for gender and different ethnic backgrounds may contribute to a better understanding of the obesity-attainment association.

Currently, 200 million school-aged children are classified as overweight worldwide (IOTF, 2010). In addition to the threat to physical health, this large group of children is at risk of poor academic achievement in school. This might also have long-term consequences on an individual's later life opportunities, health and economic growth of the countries. Since the reviewed literature was entirely observational, causality between high body weight status and poor school performance cannot be inferred. Reciprocal causation might be possible in that poor academic outcomes may lead to low self-esteem and depression (van Lier et al., 2012) which in turn may cause increased food intake as coping strategy and thus excess fat accumulation in the body. Additionally, observational evidence is vulnerable to confounding factors; even after controlling for a number of confounding and mediating factors, there always remain variables unaccounted for that may influence both obesity and academic achievement (e.g., genetic factors). Therefore, research investigating long-term associations and causality between obesity and academic achievement are needed. Nevertheless, overall evidence from the reviewed studies does allow one to hypothesise that interventions for child weight management might incur a range of additional benefits.



**Table 2.2: Studies categorised by direction and impact of the association between child obesity and educational attainment**

<b>Positive (statistically significant)</b>	<b>Positive (trend)</b>	<b>No significant relationship</b>	<b>Negative (trend)</b>	<b>Negative (statistically significant)</b>
Eide et al., 2010 [OW and math scores in boys, OW and reading scores in boys and girls]	Chowdhury, 2008 [obesity and academic achievement in all ethnic groups, girls' mathematics scores]	Averett and Stifel, 2010 [OW and reading scores]	Abdelalim et al., 2012 *	Averett and Stifel, 2010 [OW and maths scores]  Averett and Stifel, 2007
Welk et al., 2010 <sup>+</sup>	<b>Datar and Sturm, 2006</b> [persistently OW girls and reading scores]	Barrisgas and Fragoso, 2012	Bisset et al., 2012 [obesity and measured reading and language skills]*	Cho et al., 2009
Chowdhury, 2008 [obesity and educational attainment in Black and Hispanic > 10yrs, obesity in boys and reading scores]	Kaestner et al., 2009 [obesity in boys and attainment]	Bisset et al., 2012 [OW and teacher reported achievement]	Krukowski et al, 2009* <sup>#</sup>	Clark et al., 2009
Gregg et al., 2008 <sup>+</sup>	Kaestner and Grossmann, 2009 [obesity and attainment in boys and 9-10yr old girls]	Du Troit et al., 2011 <sup>+</sup>	<b>Veldwijk et al., 2012*</b> [persistent OW and educational attainment]	Davis and Cooper, 2011

Table 2.2 (continued)

<b>Positive (statistically significant)</b>	<b>Positive (trend)</b>	<b>No significant relationship</b>	<b>Negative (trend)</b>	<b>Negative (statistically significant)</b>
Pesa et al., 2000		Edwards et al., 2011 <sup>+</sup>	MacCann and Roberts, 2013*[obesity, not OW and mathematics and vocabulary scores]	Do and Finkelstein, 2011 <sup>#</sup>
		Eveland-Sayers et al., 2009 <sup>+</sup>	Baxter et al., 2013* [OB and science scores in boys only]	Du Troit et al., 2011 <sup>+</sup> [%BF and academic achievement in 11 yrs old girls]
		Gunnardottier et al., 2012	Bagully, 2006*	Florin et al., 2011 <sup>#</sup>
		Kim et al., 2003 <sup>+</sup>	Chomitz et al., 2009 <sup>*</sup>	Fonseca et al., 2010 <sup>+#</sup>
		Gurley-Calvez and Higginbotham, 2010 [obesity and mathematics achievement]	Chowdhury, 2008 [obesity and girls' reading scores]	Fuxa and Fulkerson 2011 <sup>#</sup>
		Hill-Jones, 2008 <sup>+</sup>	Cottrell et al., 2007*	Gurley-Calvez and Higginbotham, 2010 [obesity and reading achievement in school of low SES]
		Hillman et al, 2012 <sup>+</sup> Kukulu et al., 2010 <sup>+</sup>	Crosnoe and Muller, 2004* Datar et al., 2004*	Han 2012 Kafyulio and Mfumiko, 2011 <sup>+#</sup>

Table 2.2. (continued)

Positive (statistically significant)	Positive (trend)	No significant relationship	Negative (trend)	Negative (statistically significant)
		LeBlanc et al., 2012	<b>Datar and Sturm, 2006</b> [persistently OW girls and maths scores, all boys and maths and reading scores]	Kamijo et al, 2012
		Padilla-Moledo et al, 2011 <sup>+#</sup>	Ding et al., 2006 [obesity and educational attainment in boys] <sup>#*</sup>	Kristjánsson et al., 2010 <sup>#</sup>
		Palermo and Dowd, 2012 [OW&OB and reading scores in boys of all ethnic groups and Black, Hispanic girls] Ramaswamy et la., 2010 <sup>+</sup> Sanchez-Lopez et al., 2009 <sup>#</sup>	Fletcher and Lehrer, 2008 <sup>*#</sup>  <b>Gable et al., 2008</b> Huang et al., 2006* [BMI, %BF and measured academic achievement]	Palermo and Dowd, 2012 [OB and reading scores in white girls]  Perez-Chada et al., 2009 Praphul et al., 2011 <sup>+</sup>
		Van Dusen et al., 2011  <b>Telford et al., 2012</b>	Judge and Jahns, 2007*  Baxter et al., 2013* [BMI centile and science scores in boys]	Roberts et al., 2010  Elrod, 2008 <sup>+</sup>

Table 2.2 (continued)

Positive (statistically significant)	Positive (trend)	No significant relationship	Negative (trend)	Negative (statistically significant)
		Baxter et al., 2013 [BMI centile and academic achievement in girls, boys all subjects but science]	Kaestner et al, 2009*	Von Hinke-Kessler Scholder et al., 2009, 2012 [fat mass and educational attainment at 11 years in OLS, FE and IV models]
		<b>Mo-suwan et al., 1999</b> [developing OW and educational attainment in 8-13 yrs olds]	Li et al., 2008*	MacCann and Roberts, 2013 <sup>#</sup> [OW, OB and BMI and average grades]
		Tershakovec et al., 1994	Sabia, 2007* <sup>#</sup> [obesity and academic achievement in white boys, and non-white boys and girls]	Kantomaa et al, 2013
		<b>Carter et al., 2010</b> [persistent and developing obesity and maths scores]	Shore et al., 2008 [OW and reading scores]	Castelli et al., 2007
		<b>Chen et al., 2012</b>	Von Hinke Kessler Scholder et al., 2012 [fat mass and educational attainment aged 9 yrs in IV model]	<b>Datar and Sturm, 2006</b> [newly OW girls and maths and reading scores]
		<b>Li and O'Connell, 2012</b>	Wang and Veugelers, 2008	Ding et al., 2006 <sup>#</sup> [obesity and educational attainment in girls]

Table 2.2 (continued)

Positive (statistically significant)	Positive (trend)	No significant relationship	Negative (trend)	Negative (statistically significant)
		Eide et al., 2010 [math scores in OW girls]	Palermo and Dowd 2012* [OW and reading scores in white girls]	Florence et al., 2008
		Helbig and Jaehnen, 2013 [math attainment in OW boys and girls, German attainment in OW/OB boys and girls]	<b>Booth et al., 2014*</b> [English, math, and science scores for persistently OW+OB boys]	Huang et al., 2006 <sup>#</sup>
		<b>Booth et al., 2014</b> [English, math and science grades and weight change from OW/OB to healthy weight developing OW/OB from healthy weight in boys and girls]	Helbig and Jaehnen, 2013* [Math attainment in OB boys and girls]	Kaestner and Grossman, 2009 [obesity in 11-12 yrs old girls and reading comprehension]
		<b>Veldwijk et al., 2012</b> [becoming OW and educational attainment scores]		Mikkila et al, 2003 Sabia, 2007 <sup>#</sup> [obesity in white girls aged 14-17 yrs and educational attainment] Shore et al., 2008 [obesity and average attainment scores] Sigfusdottir et al., 2007 <sup>#</sup> <b>Wendt 2009</b>

Table 2.2. (continued)

Positive (statistically significant)	Positive (trend)	No significant relationship	Negative (trend)	Negative (statistically significant)
				<b>Mo-suwan et al., 1999</b> [OW and developing OW and educational attainment in 13-15 yrs olds] <b>Carter et al., 2010<sup>+</sup></b> [persistently OB and PPVT scores] <b>Gable et al., 2012</b> <b>Booth et al., 2014</b> [English, math, and science scores for persistently OW+OB girls and OW→OB girls]
Note: Where studies appear in more than one column details for specific outcomes are presented. Bold references indicate prospective cohort studies. OW: overweight, OB: obese, PPVT: Picture Vocabulary Test Scores * Negative association weakened after controlling for confounders and mediators <sup>+</sup> no adjustment for confounding and mediating variables, correlation analyses or group comparison only <sup>#</sup> self-reported or parental reported attainment scores				

**Table 2.3: Association between childhood overweight/obesity and educational attainment – Cross-sectional studies**

Reference	Country	Sample characteristics	Adiposity measures	Educational attainment measures	Confounders/mediators	Statistical methods	Results
(Abdelalim et al., 2012)	Kuwait	N = 999 Age: 10 y Sex: 100% (m) OW: 21.8% OB: 17.4%	BMI <sup>a</sup>  BMI z-score  Cut-offs based on CDC growth charts percentiles	Mathematics, Science, Arabic literature, total grades  School records	Parental educational level, nationality, type of housing, presents of chronic disease, child's living arrangements	Kruskal-Wallis  Unconditional logistic regression	<ul style="list-style-type: none"> <li>• OW students scored significantly higher than OB and normal weight students</li> <li>• no sig. association between OW/OB and academic achievement after adj. for confounders</li> </ul>
(Averett & Stifel, 2010)	USA	N = 7,446 Age: 6-13y Sex: not reported BMI z-score: not reported	BMI <sup>a</sup> z-score	Mathematics, reading  Peabody Individual Achievement Test	Household income, whether breastfed, mothers education level,  IV: mothers BMI and BMI <sup>2</sup> in 1981	Ordinary least square regression (OLS) Fixed effect models (FE) Instrumental variable models (IV)	<ul style="list-style-type: none"> <li>• OLS: OW associated with lower math scores in white &amp; black boys &amp; girls (P&lt;.05), n.s. for reading scores</li> <li>• FE: n.s. negative association</li> <li>• IV: low reading scores OW black (-11.8 points) &amp; white (-11.4 points) boys (P&lt;.01), n.s. in girls; low math scores in OW white girls (-6.0 points) and black (-0.5 points) &amp; white boys (-18.7 points = 1SD below peers) (P&lt;.05)</li> </ul>

Table 2.3 (continued)

Reference	Country	Sample characteristics	Adiposity measures	Educational attainment measures	Confounders/mediators	Statistical methods	Results
(Barrigas & Fragoso, 2012)	Portugal	N = 721 Age: 6-12 y Sex: 48.0% (f) OW: 21.5% (f), 15.5% (m) OB: 6.1% (f), 5.1% (m)	BMI <sup>a</sup>  Cut-offs based on IOTF classification  Skinfolds (triceps + subscapular)	Portuguese, Mathematics, Science  Teacher reports	Age, maturity, SES (parents' occupation and literacy, home location and characteristics)	Univariate analysis of covariance (ANCOVA)	• no difference between BMI category and academic achievement after adjustment for all covariates
(Baxter et al., 2013)	USA	N = 1,504 Age: 12 y Sex: 53.7% (f) OW: 19.3% OB: 29.6%	BMI <sup>a</sup>  Cut-offs based on CDC growth charts percentiles	English, math, social studies, and science  Palmetto Achievement Challenge Tests	SES, school year	first-order marginal and higher-order regression models, stratified by gender	• n.s association between OW/OB and all subjects in girls • negative association between OW/OB in boys and science ( =-0.047, P<.02), n.s after Bonferroni-correction
*(Bisset et al., 2013)	Canada	N = 1,959 Age: 4-7y (baseline), 8.2 (follow-up) Sex: 49.7% (f) OW: 6.5%	BMI <sup>b</sup>  Cut-offs based on IOTF classification	Reading, Mathematics, Writing: Teacher report  Reading comprehension, vocabulary: Kaufman's Assessment Battery for Children	Gender, breastfeeding duration, whether low birth weight, socio-familial adversity index, cognitive abilities aged 3y and 7y, internalizing/externalising behaviour problems	Latent class growth analysis  Multivariate regression	• n.s. negative relation between OW and KABC test performance after adj. for breast feeding and family risk  • n.s. relation between OW and school performance



Table 2.3 (continued)

Reference	Country	Sample characteristics	Adiposity measures	Educational attainment measures	Confounders/mediators	Statistical methods	Results
(Cho et al., 2009)	Korea	N = 1,346 Age: high school Sex: 46.0% (f) OW:14%	BMI <sup>b</sup>  Cut-offs based on CDC growth charts percentiles	Mathematics, Korean, English  College Scholastic Ability Test	Household income, mother's education level, leisure activities (exercise, screen time, club activities), lifestyle and health (sleep, alcohol consumption, breakfast habits, smoking, health status), study hours, sex, region	Simultaneous prohibit-linear regression model	<ul style="list-style-type: none"> <li>• 1 unit of BMI is associated with 18.5 units in school performance (<math>P&lt;.05</math>)</li> <li>• 1 unit of school performance is associated with BMI by 5.3% (<math>P&lt;.05</math>)</li> </ul>
(Clark et al., 2009)	USA	N = 9,471 Age: 5-10y Sex: 48.5% (f) OW: 17.0% OB: 19.7%	BMI <sup>a</sup>  Cut-offs based on CDC growth charts percentiles (2007)	Reading, Mathematics, Language, Social Science, Science  Texas Assessment of Knowledge & Skills (TAKS)  Teacher reports	Eligibility for free or reduced school lunch, conduct grades	Mann-Whitney's U  Cohen's <i>d</i>  Kruskal-Wallis  Bonferroni correction  Partial correlation	<ul style="list-style-type: none"> <li>• average grade in every subject area OB &lt; Non-OB: ES 0.21-0.23</li> <li>• average grade in every subject area OB &lt; OW &lt; healthy weight: ES for each subjects: 0.06</li> <li>• sig. lower TAKS scores in all subject areas for OB compared to OW and healthy weight</li> <li>• sig. negative correlation between BMI and grades/ TAKS when adj. for SES and conduct (<math>r = -.06 - -.09</math>)</li> </ul>

Table 2.3 (continued)

Reference	Country	Sample characteristics	Adiposity measures	Educational attainment measures	Confounders/mediators	Statistical methods	Results
(Davis & Cooper, 2011)	USA	N = 170 Age: 7-11y Sex: 56.0% (f) OW: 100%	BMI <sup>a</sup> z-scores  Waist circumference  Body fat % (DEXA)  Abdominal fat	Reading and Mathematics  Woodcock-Johnson Tests of Achievement III	ethnicity, gender, parents'/carer's education level	Partial correlation	• sig. negative correlation between maths and reading scores and BMI z-scores (-.23, -.20), waist circumference (-.28, -.21), body fat % (-.23,-.20) and abdominal fat (-.31, -.22)
(Do & Finkelstein, 2011)	South Korea	N = 142 783 Age:13-18y Sex: 47.6 (f) OW: 9.1% OB: 4.2%	BMI <sup>b</sup>  Cut-offs based on Korean CDC and Prevention Criteria growth charts percentiles	Overall school performance:  Self-reported (high, mid-high, middle, mid-low, low)	Self-reported: body image stress, health status, parents' education level, household economic status, number of cars, no own bedroom, number of computers at home, residential area type, school level within school type (middle, high, vocational high), survey year	Ordered prohibit regression analysis	• sig neg. association between OW/OB and low school performance in middle and general high school (OB boys -.20, OB girls -.31, OW boys -.10, OW girls -.14)
(Du Toit et al., 2011)	South Africa	N = 212 Age: 9-12 y Sex: 55.7% (f) BMI [kg/m <sup>2</sup> ]= 18.9 ± 4.1 BF% = 20.6 ± 8.3	BMI <sup>a</sup>  %BF (Skinfold)	Average end-of-year academic marks of the subjects Languages, Mathematics, Natural science, Technology, Social science, Art & Culture, Life Orientation, Economic & Management Science  National Curriculum	None reported	Spearman correlation coefficient  Stepwise discriminant analysis	• negative correlation between %BF and academic achievement in 11y old girls only (r = -0.34, p<.05) • n.s. negative correlation between BMI and academic achievement • %BF is no discriminating factor between low and high academic achievers

Table 2.3 (continued)

Reference	Country	Sample characteristics	Adiposity measures	Educational attainment measures	Confounders/mediators	Statistical methods	Results
(Edwards et al., 2011)	USA	N = 800 Age: 11y Sex: 48.3% (f) OW: 16.4% OB: 12.5%	BMI <sup>a</sup>  Cut-offs based on CDC growth charts percentiles (2000)	Mathematics, Reading  Measures of Academic Progress (MAP)	None reported	One-way ANOVA	• no association between MAP scores and OW/OB
(Eide et al., 2010)	USA	N = 2,562 Age: 5-18y Sex: 50.0% (f) OW: 58%	BMI <sup>b</sup>  Cut-offs based on CDC growth charts percentiles	Mathematics + reading test:  Woodcock-Johnson Revised Test of Achievement, Form B	Age, birth weight, race/ethnicity, region of living, grade in school	Ordinary Least Squared  quantile regression at 10 <sup>th</sup> , median, 90 <sup>th</sup> test score percentile	<ul style="list-style-type: none"> <li>• positive association between OW and math scores only in boys (P&lt;.001)</li> <li>• positive association between OW and reading scores in boys in lowest quantile of test scores (P&lt;.05) and girls overall (P&lt;.10)</li> </ul>
(Eveland-Sayers et al., 2009)	USA	N = 134 Age: 8-11y Sex: 46.0% (f) BMI[kg/m <sup>2</sup> ]: 20.96 ± 4.73	BMI <sup>a</sup>	Mathematics + reading/language test:  2005 Terra Nova Test	Gender	Pearson's Product Moment Correlation	• n.s. negative correlation between BMI and math + reading/language test scores
(Florin et al., 2011)	USA	N = 11,012 Age: 14-17y Sex: 51.1% (f) OW: 29.8% OB: 10.7%	BMI <sup>b</sup>  Cut-offs based on CDC growth charts percentiles	Grade point average (GPA)  Self-reported (A-F)	Age, sex, ethnicity, depression, television usage, video game usage, physical activity	Ordinal logistic regression analysis	<ul style="list-style-type: none"> <li>• Report of higher grades in OW/OB (P for trend &lt;.001)</li> <li>• reduced odds of reporting grades a category higher by 17% in OW (P&lt;.003, 95% CI 0.74-0.94) and by 19% in OB (P&lt;.01, 95% CI 0.69-0.95) after adj. for confounders/mediators</li> </ul>

Table 2.3 (continued)

Reference	Country	Sample characteristics	Adiposity measures	Educational attainment measures	Confounders/mediators	Statistical methods	Results
(Fonseca et al., 2011)	Portugal	N = 17,024 Age : 11y, 13y, 15y, >16y Sex : 51.9% (f) OW : 17.2%	BMI <sup>b</sup>  Cut-offs based on IOTF classification	Overall school performance  Self-reported (very good, good, average, below average)	None reported	Bivariate analysis	• OW is associated with report of lower school performance compared to normal weight peers ( $\chi^2 = 8.30$ , $P < .05$ )
(Fuxa & Fulkerson, 2011)	USA	N = 77,110 Age: 14y, 17y Sex: 50.6%(f) OW: 13% OB: 9 %	BMI <sup>b</sup>  Cut-offs based on CDC growth charts percentiles (2009)	Grade point average (GPA)  Self-reported (A-F)	Grade in school, ethnicity, living situation, region, free or reduced-price lunch	Linear modelling  Cohen's <i>d</i>	<ul style="list-style-type: none"> <li>• lower GPA in OW and OB than in normal-weight (<math>P &lt; .001</math>)</li> <li>• ES between non-OW and OW: 0.13 (m), 0.14(f)</li> <li>• ES between Non-OW and OB: 0.38 (m), 0.42 (f)</li> <li>• ES between OW and OB: 0.22 (m), 0.25 (f)</li> </ul>
(Gunnarsdottir et al., 2012a)	Iceland	N = 84 Age: 7-13y Sex: 45.3% (f) OB: 100% BMI-SDS: 2.14-4.59	BMI <sup>a</sup>  Cut-offs based on IOTF classification  BMI-SDS: relative to Swedish reference population	General academic abilities in mathematics and reading  Teacher-reported (lowest 10%, next 20%, average 40%, next highest 20%, highest achieving 10%)		Correlation (not specified in report)	• n.s. correlation with teacher-reported achievement

Table 2.3 (continued)

Reference	Country	Sample characteristics	Adiposity measures	Educational attainment measures	Confounders/mediators	Statistical methods	Results
(Gurley-Calvez & Higginbotham, 2010)	USA	N = 272 Age: 9-10y Sex: 48.4% (f) OW: 44.1% OB: 26.3%	BMI <sup>a</sup>  Cut-offs based on CDC growth charts percentiles (2000)	Reading and Mathematics Proficiency  WESTEST2	Gender, previous (forth) grade scores, peer achievement levels, eligibility for free or reduced price school meals, personal income per capita, student density level, public education expenditures,	Fixed effect models with interaction term (district-level fixed effects)  Value added analysis	<ul style="list-style-type: none"> <li>• negative effect of obesity on reading proficiency for districts with high poverty</li> <li>• of one % point in OB is associated with 0.15 % point in reading proficiency</li> <li>• 1SD reduction in %OB in high poverty districts could reading proficiency by 1.1%</li> <li>• n.s. effects of OB on math proficiency</li> </ul>
* (Han, 2012)	USA	N = 2,631 Age: 14-15y Sex: not reported OB: 39%	BMI <sup>a</sup> z-scores  Cut-offs based on CDC growth charts percentiles (2000)	Reading, Mathematics  The ECLS-K eighth-grade direct cognitive assessment battery (Item Response Theory (IRT)-scale test scores)	Birth weight, soda consumption, enrolment in free or reduced price school lunch, hours of screen time, days/week of 20min of VPA, maternal education, paternal occupation, family income, neighbourhood safety, school type, reading ability in kindergarten and at school-entry	Ordinary least Square regression (OLS)  Propensity score matching	<ul style="list-style-type: none"> <li>• OLS: OB students had 0.11 SD lower than normal-weight peers, n.s. for mathematics scores</li> <li>• Matching: OB students had 0.17 SD lower reading and 0.16 SD lower mathematics scores than normal-weight peers; in severely OB (BMI&gt;97thcentile) lower reading and mathematics scores of -0.23 SD compared to normal-weight pupils</li> <li>• 20% lower mathematics achievement SD in girls than boys; n.s. OB – reading association in boys</li> </ul>

Table 2.3 (continued)

Reference	Country	Sample characteristics	Adiposity measures	Educational attainment measures	Confounders/mediators	Statistical methods	Results
(Helbig & Jähnen, 2013)	Germany	N = 1,628 Age: 7-10y Sex: 49% (f) OW/OB: not reported	BMI <sup>a</sup>  German reference population: OW > 90 <sup>th</sup> centile, OB: 97 <sup>th</sup> centile	Mathematics, German  Teacher reports	Parental education, parental occupation status, income, migration background, region (East/West Germany), region size, disability of the child, age, Health status, self-esteem, behavioural disorders, bullying, physical activity, TV viewing	Multiple regression	<ul style="list-style-type: none"> <li>• lower maths grades in OB boys and girls than normal-weight peers (<math>P &lt; .05</math> and <math>P &lt; .01</math>, respectively) after adj of parental SES</li> <li>• n.s association between OW status and maths in full model and between OW/OB for German grades</li> </ul>
(Hill-Jones, 2009)	USA	N = 35 Age: 15-19y Sex: 62.9% (f) OW: 38.5% (m), 13.6% (f) OB: 23.1% (m), 27.3% (f)	BMI <sup>a</sup>  Cut-offs based on CDC growth charts percentiles (2000)	Mathematics, English, Biology, History  Teacher reports	None reported	Independent t-test  Pearson Correlation	<ul style="list-style-type: none"> <li>• n.s difference in school achievement between OW/OB and non-OW males and females</li> <li>• n.s. negative association between OW/OB/ BMI and subject performance</li> </ul>
(Hillman et al., 2012)	USA	N = 105 Age: 8.8y Sex: 40.0% (f) BMI[kg/m <sup>2</sup> ]: 19.6 ± 4.7	BMI  (Method of assessment unreported)	Mathematics, Reading, Spelling  Wide Range Achievement Test 3 <sup>rd</sup> edition (WRAT 3)	None reported	Bivariate correlation (Pearson product-moment correlation)	<ul style="list-style-type: none"> <li>• n.s. negative correlation between BMI and academic domains</li> </ul>

Table 2.3 (continued)

Reference	Country	Sample characteristics	Adiposity measures	Educational attainment measures	Confounders/mediators	Statistical methods	Results
(Kafyulilo, 2008)	Tanzania	N = 200 Age: 5-14y Sex: not reported OW/OB: not reported	BMI <sup>a</sup>  OW = BMI $\geq 25$ kg/m <sup>2</sup> , OB = BMI $\geq 30$ kg/m <sup>2</sup>  %BF (skinfolts)	Overall academic performance  Self-report (A-F)	Not reported	Chi-Square test	<ul style="list-style-type: none"> <li>• negative association between OW/OB and academic performance (<math>\chi^2 = 64.3</math>, <math>P &lt; .001</math>)</li> </ul>
(Kamijo et al., 2012a)	USA	N = 126 Age: 7-9y Sex: 50.0% (f) OW: 20.6% OB: 23.8%	BMI <sup>a</sup> BMI <sup>a</sup> z-scores  Cut-offs based on CDC growth charts percentiles  %BF, ROI fat mass (DEXA)	Mathematics, reading, spelling  Wide Range Achievement Test 3 <sup>rd</sup> edition (WRAT3)	Age, gender, IQ (Kaufman Brief Intelligence Test), SES (free or reduced price school meals, parental education level, number of parents working full-time), VO2 max percentile	Multilevel analysis	<ul style="list-style-type: none"> <li>• BMI and BMI z-score negatively associated with spelling (<math>r = -0.21</math>, <math>P = .02</math>) and mathematics (<math>r = -0.28</math>, <math>P = .002</math>)</li> <li>• %BF negatively associated with reading (<math>r = -0.24</math>, <math>P = .04</math>) and spelling (<math>r = -0.23</math>, <math>P = .05</math>)</li> <li>• ROI fat mass associated with lower reading (<math>r = -0.21</math>), spelling (<math>r = -0.23</math>) and mathematics (<math>r = -0.20</math>) scores (<math>P &lt; .05</math>)</li> </ul>
(Kantomaa et al., 2013)	Finland	N = 8,061 Age: 16y Sex: 48.8% (f) OW/OB: not reported	BMI <sup>b</sup>  Cut-offs based on IOTF classification	GPA of 14 subjects  National final assessment of basic education	Gender, early academic impairment, maternal education	Structural equation models	<ul style="list-style-type: none"> <li>• OB is negatively associated with GPA (<math>\beta = -0.094</math>, <math>p &lt; .001</math>)</li> </ul>

Table 2.3 (continued)

Reference	Country	Sample characteristics	Adiposity measures	Educational attainment measures	Confounders/mediators	Statistical methods	Results
(Kristjansson et al., 2010)	Iceland	N = 5,810 Age: 14-15y Sex: 51.7% (f) BMI[kg/m <sup>2</sup> ]: 21.05 ± 3.33	BMI <sup>b</sup>	Average grades in Icelandic, Mathematics, English, Danish/Swedish/Norwegian (scale 0-10):  Self-reported (under 4, about 4, about 5, about 6, about 7, about 8 about 9, about 10)	Gender, parental education, family structure, school absenteeism, self-esteem	Zero-order correlation  Structural equation model	<ul style="list-style-type: none"> <li>BMI negatively correlated with academic achievement (<math>r = -.12</math>, <math>P &lt; .01</math>)</li> <li>BMI directly and negatively related to academic achievement after adj. for confounders (<math>\beta = -.06</math>, <math>t &gt; 1.96</math>, <math>P &lt; .01</math>)</li> </ul>
(Krukowski et al., 2009)	USA	N = 1,071 Age : 4-13y Sex :47.0% (f) OW: 19.1% OB: 20.7%	BMI <sup>b</sup>  Cut-offs based on CDC growth charts percentiles	Average grades in last year:  parental reported (mostly As, Bs, Cs or Fs):	Gender, race/ethnicity, weight-related and non-weight teasing, SES (free or reduced lunch participation), school level	Chi-square test  Logistic regression models	<ul style="list-style-type: none"> <li>OW status associated with 1.5 fold risk of poor school performance; adjusted for demographics (95%CI 1.01-2.25)</li> <li>n.s. after adjustment for weight-based teasing</li> </ul>
(Kukulu et al., 2010)	Turkey	N = 737 Age: 10-15y Sex: 46.0% (f)	BMI <sup>a</sup>  Cut-offs based on CDC growth charts percentiles (2000)	Overall academic achievement  School records	Not reported	Chi-Square test	<ul style="list-style-type: none"> <li>n.s correlation between OW/OB and academic achievement</li> </ul>



Table 2.3 (continued)

Reference	Country	Sample characteristics	Adiposity measures	Educational attainment measures	Confounders/mediators	Statistical methods	Results
(LeBlanc et al., 2012)	USA	N = 1963 Age: 10.5y Sex: 60.0% (f) BMI percentile: 70 <sup>th</sup> %BF: 25.3	BMI <sup>a</sup>  Cut-offs based on CDC growth charts percentiles (2000)  BMI z-scores %BF (BIA)	English, mathematics, social studies, science  Department of Education	SES (free or reduced school lunch), gender, age	Canonical correlation  ANCOVA (controlled for random school-effects)	<ul style="list-style-type: none"> <li>• n.s. correlation between adiposity measures and academic scores at <math>P &lt; .01</math></li> <li>• no difference in academic achievement between normal weight, OW or OB</li> </ul>
(MacCann & Roberts, 2013)	USA	N = 383 Age: 12-15y Sex: 49% (f) OW: 13.8% OB: 8.1%	BMI <sup>b</sup>  WHO Reference 2007	Mathematics, vocabulary, average grade of English, mathematics, science, social studies  National Assessment of Educational Progress, Vocabulary Level Test, self-report (A-F 13-point scale)	Gender, ethnicity, parental education, geographical region, Conscientiousness and life satisfaction	Partial correlation ANCOVA Cohen's <i>d</i>	<ul style="list-style-type: none"> <li>• lower average grades in OW/OB children compared to normal weight peers (ES: OW – 0.5, OB – 0.4; <math>P &lt; 0.05</math>)</li> <li>• sig negative association between BMI and average grades (<math>r = -0.18</math>, <math>P &lt; 0.01</math>)</li> <li>• n.s. lower math and vocabulary scores in OW/OB (BMI) children compared to normal weight peers</li> </ul>
(Padilla-Moledo et al., 2012)	Spain	N = 659 Age: 6-18y Sex: 46.6% (f)	BMI <sup>a</sup> Cut-offs based on IOTF classification  %BF (triceps + calf skinfolds) FITNESSGRAM® Healthy Fitness Zones	Overall school performance  Self-reported (very good, good, average, under average)	Gender	Binary logistic regression	<ul style="list-style-type: none"> <li>• sig. negative association between BMI (<math>r = -.13</math>) and %BF (<math>r = -.10</math>) only in children aged 6-12y (<math>P &lt; .05</math>)</li> <li>• n.s. higher risk of low school performance in OW/OB children (6-12y)</li> </ul>

Table 2.3 (continued)

Reference	Country	Sample characteristics	Adiposity measures	Academic achievement measures	Confounders/mediators	Statistical methods	Results
(Palermo & Dowd, 2012)	USA	N = 2820 Age: 5-19y Sex: 50.0%(f) OW: 15% OB: 21%	BMI <sup>a</sup>  Cut-offs based on CDC growth charts percentiles	Reading, language  Woodcock Johnson Revised Test of Achievement	Ethnicity, gender, age, parental education, SES, household income, survey year	ANOVA  Ordinary least Square regression (OLS)  Fixed effect analysis (FE)	<ul style="list-style-type: none"> <li>• OB students had lower scores in reading and language skills compared to OW and Non-OW (<math>P&lt;.05</math>)</li> <li>• OLS: being OB reading scores by 4.0 points in white girls only (<math>P&lt;.05</math>)</li> <li>• FE: n.s. association</li> </ul>
(Perez-Chada et al., 2009)	Argentina	N = 2,210 Age: 9-17y Sex: 43.5% (f) OW: 60%	BMI <sup>b</sup>  Cut-offs based on IOTF classification	Mathematics, language  School records	Age, gender, sleep hours during the week and weekend	Not reported	<ul style="list-style-type: none"> <li>• being in higher BMI quintile is associated with lower academic performance (<math>P&lt;.001</math>) and failing tests (<math>P&lt;.05</math>)</li> <li>• increased BMI increased the odd of failing in mathematics by 3% (95%CI 1.01-1.06)</li> </ul>
(Praphul et al., 2011)	USA	N = 19,695 Age: 9y, 13y, 15y Sex: not reported OW: 31% OB: 19%	BMI <sup>a</sup>  Cut-offs based on CDC growth charts percentiles	Mathematics and reading  Louisiana Education Assessment Program (LEAP)	Ethnicity, gender	Pearson's Chi-Square	<ul style="list-style-type: none"> <li>• negative association between OW/OB and math and reading scores (<math>P&lt;.05</math>)</li> </ul>

Table 2.3 (continued)

Reference	Country	Sample characteristics	Adiposity measures	Educational attainment measures	Confounders/mediators	Statistical methods	Results
(Ramaswamy et al., 2010)	USA	N = 45 Age: 7-12y Sex: 53.3% (f) OW: 71% %BF: 5.5 – 47.5	BMI <sup>a</sup>  OW cut-off reference not reported  %BF (BIA)	English, Reading, Mathematics, Social studies, Science  Teacher reports	Gender, age, ethnicity, grade score	Zero order correlation	• n.s. positive correlation between BMI and average grades
(Roberts et al., 2010)	USA	N = 1,989 Age : 10y, 12y, 14y Sex : 49.1% (f) OW : 16.2% OB : 13.6%	BMI <sup>a</sup>  Cut-offs based on CDC growth charts percentiles	Mathematics, Reading, Language  California Standard Test (CST) California Achievement Test Version 6 (CAT6)	Eligibility for free/reduced price school lunch, sex, ethnicity	Hierarchical linear regression models	• CST and CAT6 scores after adj. for confounders: OB<OW<normal weight (P<.05)  • negative linear trend between BMI and test scores for CST math (P=.013), CST language (P=.007), CAT6 maths (P=.007), CAT6 reading (P=.028)
(Sanchez-Lopez et al., 2009)	Spain	N = 1,073 Age: 11-13y Sex: 50% (f)	BMI <sup>a</sup>  Low = BMI<25 <sup>th</sup> centile, Medium = BMI25 <sup>th</sup> -75 <sup>th</sup> centile, High = BMI>75 <sup>th</sup> centile	Overall school achievement  Self-reported	Age	ANCOVA MANCOVA	• no correlation between higher BMI and lower achievement

Table 2.3 (continued)

Reference	Country	Sample characteristics	Adiposity measures	Educational attainment measures	Confounders/mediators	Statistical methods	Results
(Van Dusen et al., 2011)	USA	N = 254,743 Age: 7-16y Sex: 50%	BMI <sup>a</sup>  FITNESSGRAM <sup>®</sup> Healthy Fitness Zones	Reading, Mathematics  Texas Assessment of Knowledge & Skills (TAKS)	Ethnicity, free/reduced-price school lunch, grade level, cardiovascular fitness, curl-ups	Mixed effect regression (school-level random effect)	• n.s. association between the highest BMI quintile and TASK scores
(Von Hinke Kessler Scholder et al., 2012)	UK	N = 3001 Age: 14y Sex: 51.0% (f)	Fat mass (DEXA) at age 9 and 11 adjusted for height, height <sup>2</sup> , gender, age	English, mathematics, science  National exams (Key Stage 2 & 3)	Birth weight, siblings, age, family income, mother's education, whether mother smoked or drank alcohol during pregnancy, mother's mental health, maternal age at birth, length of breast feeding, raised by natural father, family's social class, parental employment status, parental involvement in child development, area deprivation, mother's BMI, percentile of child's fat mass, genetic markers (FTO, MC4R)	Ordinary Least Square (OLS)  Fixed effects analysis (FE)  Instrumental variables (IV)	<ul style="list-style-type: none"> <li>• OLS: negative correlation between KS3 and fat mass at 11y (<math>r = -.042</math>, <math>P &lt; .01</math>) and KS2 and fat mass at 9y (<math>r = -.025</math>, <math>P &lt; .1</math>)</li> <li>• FE: fat mass negatively affects child's educational outcome at both exam stages (<math>r = -.03</math>, <math>P &lt; .1</math>)</li> <li>• IV: similar results as for OLS for mother's BMI and child's fat mass at 11y</li> </ul>

Table 2.3 (continued)

Reference	Country	Sample characteristics	Adiposity measures	Educational attainment measures	Confounders/mediators	Statistical methods	Results
(Welk et al., 2010)	USA	N = 36,835 Age: 7-17y Sex : 49.8% (f)  Data from 2007-2008 included 1,053 school districts	BMI <sup>a</sup>  FITNESSGRAM ® Healthy Fitness Zones	Reading, Mathematics, Language, Social Science, Science  Texas Assessment of Knowledge & Skills (TAKS)	Ethnicity, free/ reduced-cost school lunch, school size	Spearman Correlation	• low positive correlation between TASK and BMI (r=.24)

\* denotes studies that are prospective in nature but reported educational attainment for one time point only, f: female, m: male, OW: overweight, OB: obesity, OW+: always overweight, OW -/+ : developed overweight, OW: overweight, NOW: non-overweight, BMI: body mass index, BMI-SDS: body mass index standard deviation score, BF: body fat, <sup>a</sup>: objectively measured weight and height, <sup>b</sup>: self-reported weight and height, IOTF: International Obesity Task Force, CDC: Centre of Disease Control, NHANES I: First National Health and Nutrition Examination Survey, ROI: region of interest, SES: socio-economic status, n.s.: non-significant (P>.05), adj.: adjustment, ES: effect size, ECLS-K: Early Childhood Longitudinal Study-Kindergarten Class of 1998–99, VPA: vigorous physical activity, DEXA: dual-energy x-ray absorptiometry, ANOVA: Analysis of variance, MANCOVA: Multivariate analysis of variance

**Table 2.4: Association between overweight/obesity and educational attainment – Longitudinal studies**

Reference	Location	Sample characteristics	Adiposity measures	Educational attainment measures	Confounders/mediators	Statistical methods	Results
(Booth et al., 2014)	UK	N = 4,260 Age: 11yrs (baseline), 13 yrs & 16yrs (follow-up) Sex: 55% (f) OW: 13.3% OB: 15.5% OW/OB +: 15.8% OW-/+: 4.8% OB-/+: 1.2% OW/OB +/-: 8.3% OW→OB: 2.2%	BMI <sup>a</sup> z-score  UK 1990 reference population	English, Math, Science  Standardised National Exams (Key Stage 2 & 3)	Age, birth weight, gestation; age of mother at delivery, mother's oily fish intake during pregnancy at 32 weeks gestation, maternal smoking in the first three months of pregnancy; pubertal status, menarche status, maternal education, maternal occupational status, MVPA/week, depressive symptoms, full IQ, BMI z-score at age 16yrs	Linear regression	<ul style="list-style-type: none"> <li>• lower English, maths and science grades in OB girls than normal-weight girls at 13y ( <math>\beta_{\text{English}} = -0.08</math>, <math>P &lt; .01</math>) and 16y ( <math>\beta_{\text{English}} = -0.07</math>, <math>P &lt; .05</math>)</li> <li>• lower grades in persistently OW/OB girls ( <math>\beta_{\text{English}} = -0.2</math>, <math>P &lt; .05</math>) and OW→OB girls ( <math>\beta_{\text{English}} = -0.5</math>, <math>P &lt; .05</math>)</li> <li>• n.s. association for OW/OB boys and OW girls</li> <li>• n.s. association for OW-/+, OB-/+, OW/OB +/-</li> </ul>
(Carter et al., 2010)	Canada	N = 2,582 Age : 2-5y (baseline), 8-11y (follow-up) Sex: 48.0% (f) O-: 68.9% O-/+: 6.7% O+/-: 21.4% O+: 3.0%	BMI <sup>b</sup>  Cut-offs based on IOTF classification	Academic aptitude test (2-5y): Revised Peabody Picture Vocabulary Test (PPVT-R)  Math test (8-11y): Mathematics Computation Test of CAT/2, shortened version (IRT)	Age, gender, ethnicity, sleep, physical activity, chronic condition status, birth weight, household income, family structure; maternal education, working status, age at birth of child, smoking status, degree of positive parenting	Bivariate analysis  Multiple linear regression	<ul style="list-style-type: none"> <li>• PPVT-R scores in O+ than O- children (<math>P &lt; .01</math>)</li> <li>• no difference between O-, O+/- and O-/+ in PPVT-R</li> <li>• higher math scores in O+/- students than O- (<math>P &lt; .0001</math>)</li> </ul>

Table 2.4 (continued)

Reference	Location	Sample characteristics	Adiposity measures	Educational attainment	Confounders/mediators	Statistical methods	Results
(Chen et al., 2012)	Taiwan	N = 409 Age: 6y (baseline), 12 y (follow up) Sex: 48.4% (f) OW baseline: 15..2% (f), 18.8% (m) OW (follow-up): OW+: 12%(f), 18%(m) OW-/+: 9.5% (f), 17%(m)	BMI <sup>a</sup>  Cut-offs based on IOTF classification	Mean score of language, mathematics, science, social studies:  School records	School absenteeism, IQ (Raven's Colored Progressive Matrices), gender, parental education, number of siblings, family structure	Multivariate linear regression  Latent growth curve analysis (conditional/ Unconditional)	<ul style="list-style-type: none"> <li>• n.s. negative association between change in weight status and academic performance</li> <li>• BMI intercept n.s. related to intercept of academic performance</li> <li>• n.s. slower increase in academic performance in children with high baseline BMI</li> </ul>
(Gable et al., 2012)	USA	N = 6,250 Age: 5.7y (baseline), 11.2y (follow-up) Sex: 52.0% (f) O-: 80.3% O+: 11.8% O-/+: 8%	BMI <sup>a</sup>  Cut-offs based on CDC growth charts percentiles (2000)	Mathematics  ECLS-K test based on Woodcock-McGrew-Werder Mini-Battery of Achievement	Child age at study enrolment, ethnicity, maternal education, maternal employment status, parental psychological well-being, parent expectations of child educational achievement, household income, family structure, child's interpersonal skills, internalising behaviour	Three-level random coefficient model	<ul style="list-style-type: none"> <li>• O+ associated with lower math scores by 2.07 points in boys and 1.72 points in girls compared to O- (P&lt;.001)</li> <li>• O-/+ associated with lower math scores by 1.22 in boys and 1.62 in girls compared to O- (P&lt;.05)</li> </ul>
(Li & O'Connell, 2012)	USA	N = 6,178 Age: 5.7y (baseline), 11.2y (follow-up) Sex: 50.0% (f) OB: 11.2% (baseline), 20.3% (follow up)	BMI <sup>a</sup>  Cut-offs based on CDC growth charts percentiles (2000)	Mathematics, reading  ECLS-K test based on Woodcock-McGrew-Werder Mini-Battery of Achievement	Gender, ethnicity, SES, parental education, mother's education, single-parent household, primary language at home, school type, school location, percentage minority	Three-level random coefficient model	<ul style="list-style-type: none"> <li>• n.s. negative association between being OB and academic performance</li> <li>• being OB explained 12.4% of variation in mathematics and 16% in reading performance between children (P&lt;.001)</li> </ul>

Table 2.4 (continued)

Reference	Location	Sample characteristics	Adiposity measures	Educational attainment	Confounders/mediators	Statistical methods	Results
(Telford et al., 2012)	Australia	N = 757 Age: 8.5y (baseline), 10.5y (follow-up) Sex: 47.0% (f) %BF: 24% (m), 28% (f)	BF (DEXA)	Mathematics, reading, writing  Local government education authority	SES	Three-level fixed effect model	<ul style="list-style-type: none"> <li>• n.s. association between %BF and achievement between children</li> <li>• between schools: one % increase in BF associated with reading scores by 5.5 points (P=.05) and mathematic scores by 6.5 points (P=.02)</li> </ul>
(Veldwijk et al., 2012)	The Netherlands	N = 2,159 Age: 8y (baseline), 12y (follow-up) Sex: 51% (f) OW: 14% OB: 3% OW-/+: 4% OW+: 9%	BMI <sup>a</sup> at 8y BMI <sup>b</sup> at 12y  Cut-offs based on IOTF classification	Summary score of Spelling, mathematics, study skills, world studies  Cito-test z-scores	Gender, maternal smoking, maternal age at birth, breastfeeding duration, birth weight, parental education, lifestyle factors (physical activity, screen time, breakfast skipping), child's psychological health, being bullied, school absenteeism due to illness	Univariate and multivariate multiple regression analysis	<ul style="list-style-type: none"> <li>• n.s. negative association between school performance and OW at 8y + 12y, OW+ and OW-/++ after controlling for confounders</li> </ul>

f: female, O-: never obese, O-/+: became obese, O+/+: grew out of obesity, O+: always obese, OW+: always overweight, OW -/+: became overweight, OW: overweight, NOW: non-overweight, RO: risk of obesity, BMI: Body mass index, <sup>b</sup>: self/parental reported weight and height, IOTF: International Obesity Task Force, CAT/2: The Standardized Canadian Achievement Test: 2<sup>nd</sup> edition, IRT: item response theory, Cito-test: Central Institute for Test Development test, IQ: intelligence quotient, ECKS-K: Early Childhood Longitudinal Study-Kindergarten Cohort, n.s.: non-significant (P>.05)



## **2.2. Association between childhood obesity and cognitive function**

It is well established that general intelligence is a predictor of educational attainment (Gustafsson & Undheim, 1996). A large scale longitudinal study of 74,403 English children investigated the association between intelligence (using the Cognitive Ability Scale) at age 11 years and educational attainment (General Certificate of Secondary Education) at 16 years (Deary et al., 2007). Researchers indicated that intelligence and overall educational attainment was strongly correlated ( $r=0.69$ ) with moderate to strong correlation in 25 specific subjects. The correlation coefficients between intelligence and educational attainment in Art and Humanities (e.g. English) was 0.47 – 0.67, in Science (e.g. mathematics) was 0.46 – 0.77, in Social Science (e.g. history) was 0.47 - 0.65, and Practical (e.g. music) was 0.43 – 0.55. Another UK based study among 1,678 children aged nine years indicated that cognitive ability, measured using the Wechsler Intelligence Scale for Children (3<sup>rd</sup> edition), explained between 20% and 24% of the variation in educational attainment (teacher assessed based on National Curriculum criteria) (Spinath et al, 2006). Therefore, lower cognitive function might be considered a mediating factor in the association between childhood obesity and educational attainment, if there is evidence of a relationship between level of obesity and cognitive function. However, the association between cognition and educational attainment might be bidirectional; education can lead to enhancement of cognitive abilities (Ceci, 1991). Evidence suggests that exposure to formal education can benefit working memory, inhibitory control, problem solving, attention, and decision making, as shown in studies comparing schooled and unschooled individuals (Baker et al., 2012).

In the paragraphs below, the relationship between obesity and a range of cognitive skills will be evaluated. If one considers a direct causal path from cognitive skills to obesity, theoretically, one might expect some cognitive skills to be more closely associated with obesity than others. For example, inhibitory control (an executive function skill) may be more closely related with weight, as children with weaker

inhibitory control may be less able to avoid the temptation of unhealthy foods. On the other hand, language/verbal ability may be less likely to influence weight. While this is acknowledged, the paragraphs below provide a comprehensive overview of the relationship between obesity and a full range of cognitive skills, including those such as language. In addition, the direction of causality which is primarily focused on is that from obesity to cognitive skill, rather than the reverse.

Since the evidence reviewed in the previous section (2.1.) suggested a negative association between childhood obesity and educational attainment there might be a similar association between child obesity and cognitive function. Systematic review and meta-analysis evidence indicated that overweight or obese primary school-aged children have a significantly lower full intelligence quotient (IQ) (8 studies; N=1,086) and performance IQ (4 studies; N=536) than normal weight children (Yu et al., 2010). There was no evidence of a significant difference in verbal IQ (4 studies; N=536) between obese and non-obese children. The weighted mean difference between obese and non-obese children for full intelligence was -2.8 (95% CI: -3.73, -1.86,  $P < 0.01$ ) and for performance intelligence was -10.0 (95% CI: -19.74, -0.26,  $P = 0.04$ ) (Yu et al., 2010). Recently, Liang and colleagues reviewed observational literature on neurocognitive correlates and obesity in 30,183 children including the following areas of cognitive functioning: general intelligence, executive functioning, attention, memory, language/verbal ability, and visuo-spatial ability (Liang et al., 2013). Findings indicated that obesity is negatively associated with executive functioning (19 studies), attention (10 studies) and visuo-spatial skills (two studies). The evidence of a negative relationship between child obesity and general intelligence (seven studies), memory (six studies) and language/verbal ability (five studies) was less convincing with the majorities or half of the reviewed studies showing no significant associations.

Through the systematic literature search from chapter 2.1 and forward citations I identified nine more recent studies which were not included in the literature review by Liang et al. (2013) and Yu et al. (2010). Table 2.5 gives an overview of the study characteristics and results of the nine reviewed studies. The

following sections describe additionally identified studies and discuss their findings critically in relation to the most recent literature reviews.

Studies were primarily published between 2010 and 2013 and conducted in the USA (Fields et al., 2013; Palermo & Dowd, 2012), Spain (Ruiz et al., 2010), Italy (Parisi et al., 2010), The Netherlands (Veldwijk et al., 2011), New Zealand (Belsky et al., 2013), India (Veena et al., 2013), and Singapore (Wong et al., 2007). One study included data of four Southeast Asian countries: Indonesia, Malaysia, Thailand, and Vietnam (Sandjaja et al., 2013). Seven studies were of cross-sectional nature, one each was a case-control study and longitudinal studies (follow-up: 3 years). The participants of the case-control studies were matched by age, gender and academic level. Using the same areas of cognitive functioning as Liang et al. (2013), executive function was assessed in all but two studies (Sandjaja et al., 2013; Wong et al., 2007), memory was assessed in five studies (Belsky et al., 2013; Palermo & Dowd, 2012; Veena et al., 2013; Veldwijk et al., 2011; Wong et al., 2007), general intelligence was assessed in three studies (Belsky et al., 2013; Parisi et al., 2010; Sandjaja et al., 2013) and attention was also assessed by three studies (Fields et al., 2013; Parisi et al., 2010; Veena et al., 2013). Additionally, Veena et al. (2013) also assessed visuo-spatial abilities. All but one study obtained weight and height measures objectively but applied different obesity classification systems as described in Table 2.3.

**Executive function.** Executive function is a term that describes a set of mental processes such as planning, problem solving, inhibition control, mental flexibility, working memory and reasoning (Chan et al., 2008; Diamond, 2013).

In total, executive function was assessed in 6,982 children and adolescents. Four of the seven studies indicated that executive function is significantly negatively associated with being obese after controlling for a number of confounding factors (Belsky et al., 2013; Fields et al., 2013; Palermo & Dowd, 2012; Parisi et al., 2010). Parisi et al. (2010) also indicated that increased BMI significantly predicted lower executive functioning. However, one study indicated a positive relationship between obesity and executive function (Veena et al., 2013). This is also in contrast to the

findings of Ruiz et al. (2010) and Veldwijk et al. (2011) who did not find a significant association between BMI and executive function.

As stated earlier, executive function is a neurocognitive term which encompasses a number of higher level cognitive abilities (e.g., planning, inhibition, and reasoning). Reviewed studies assessed different cognitive abilities defined as executive function skills, although three of the seven studies investigated the ability of problem solving. Parisi et al. (2010) used a composite score of executive function consisting of problem solving, decision making, and planning sub-scores and Fields et al. (2013) assessed impulsivity and inhibition control using separate tests. Ruiz et al. (2010) on the other hand assessed reasoning skills and Veena et al. (2013) tested reasoning and verbal fluency a test of cognitive flexibility. The use of different tests to measure executive functioning and assessment of different executive functioning abilities might be one reason for conflicting results. An explanation for the positive relationship between obesity and reasoning skills in one study might be that this study was conducted in a low-income country compared to the other reviewed studies which were conducted in high-income countries (Table 2.3). Obesity in a low-income country might reflect a better nutritional status which is beneficial for brain development at a young age and thus result in better cognitive test score.

Studies reviewed by Liang et al. (2013) on reasoning ability and inhibition control and impulsivity were consistent with Ruiz et al's (2010) and Field's et al's (2013) results, respectively. Non-significant results for some executive functions abilities might be because higher level executive functions continue to develop into adolescence and early adulthood (Best et al., 2009; Casey et al., 2005) and therefore with less variation in executive function performance during childhood. The association between child and youth obesity and problem solving skills were not reviewed by Liang et al. (2013).

**Memory.** Memory refers to mental processes that are used to acquire, store, retain, and retrieve information. According to the Atkinson-Shiffrin model there are three stages of memory; sensory memory, short-term memory, and long-term memory.

The association between childhood obesity and memory performance was assessed in six studies, with a total of 4,784 children and adolescents.

Both, Wong et al. (2007) and Belsky et al. (2013) reported that significant lower short-term memory scores were obtained by obese children and youth compared to normal weight peers. Veldwijk et al. (2011) did not find convincing evidence that BMI at age 4 years predicts short-term memory performance at 7 years of age. Palermo and Dowd (2012) stated that obesity is significantly negatively associated with short and long-term memory performance whereas Veena et al. (2013) suggested a positive association between obesity and memory performance (short and long-term memory).

Conflicting findings were also noted by Liang et al. (2013); however, none of the reviewed studies (three studies) indicated a positive relationship between obesity and memory performance. Taking the overall findings of the reviewed studies together, five studies indicated a significantly negative association between childhood obesity and memory performance while two studies reported no relationship between BMI and short-term memory and one study suggested a positive relationship. The latter finding was generated in a low-income population with a high prevalence of underweight. Memory skills of obese children were compared to mostly underweight children in one group which might have suffered from lower brain development due to a poor nutritional status compared to obese children, which might have been exposed to better nutritional and developmental conditions. Inconsistent findings in high-income countries can be explained by the use of different memory tests which may assess different memory skills such as long-term or short-term memory. Different measures of adiposity (e.g. BMI z-scores versus being obese) might also contribute to conflicting findings on the obesity – memory association. To date, results of only one prospective cohort study have been published. The prospective evaluation of the obesity-memory relationship indicated a non-significant negative association, suggesting that increased BMI is not associated with a decline in memory performance over time. Since time-dependent changes were assessed by this one prospective study only, conclusions should be drawn carefully. Further longitudinal research is needed.

**Attention.** Parisi et al. (2010) studied 422 children aged 6-13 years indicating that obese children obtained lower attention scores compared to normal-weight children.

However, being overweight or obese did not significantly predict attention abilities. Group differences in attention scores between normal weight and obese children were also indicated by Fields et al. (2013) who assessed sustained attention of 61 youth aged 14-16 years. These findings are consistent with literature reviewed by Liang et al. (2013). However, findings on the predictive ability of body weight status for attention skills are lacking. One study included in Liang et al.'s review indicated that obese girls (aged 4-8 years) were at increased risk of impaired sustained attention (Mond et al., 2007). Findings so far were limited to a high-income population. Veena et al. (2013) provided results from a low-income country suggesting that obesity in 540 children aged 9-10 years is associated with better attention and concentration abilities compared to being not obese. However, the non-obese comparison group included a high proportion of underweight children. In a low-income country being obese may represent a better socio-economic status and access to food benefiting the overall nutritional status of the child which is important for optimal brain development explaining conflicting findings to research in high-income settings. On the other hand, the studies might have examined different aspects of attention (e.g. selective or direct attention) and this might be the reason for inconsistent results.

**General intelligence.** General intelligence was assessed in 8,251 children and adolescence. Using the same study population as for the assessment of the obesity-attention relationship, Parisi et al. (2010) suggested no significant difference in general intelligence (intelligence quotient) between normal weight and overweight or obese children. Additionally, there was no evidence that obesity status predicted general intelligence. Belsky et al. (2013) stated significantly lower general intelligence scores in obese children compared to normal weight children and Sandjaja et al. (2013) found that overweight and obese children were more likely to obtain non-verbal intelligence scores below the average compared to normal weight peers. However, findings from the latter research group are limited to children from Malaysia only. In Thailand and Vietnam only severely obese (BMI z-score > +3) children had increased odds of obtaining below average intelligence scores (Sandjaja et al., 2013).

Parisi et al. (2010) and Belsky et al. (2013) used the same test battery to assess total intelligence (intelligence quotient) in children of a similar age living in a developed country (Table 2.5). Inconsistency of findings might be due to the lower sample size in Parisi et al. (2010; N = 422) compared to Belsky et al. (2013; N = 1, 083). It might be that the statistical power was not sufficient to detect a significant difference in Parisi et al. (2010). A lack of consistency in results was also reported in the review by Liang et al. (2013), while the systematic review and meta-analysis by Yu et al. (2010) which included three prospective cohort studies, indicated a significant negative association between obesity and general intelligence. In the most recent published review, two out of three studies that reported no relationship between obesity and general intelligence assessed specific cognitive domains rather than providing an overall intelligence score which might explain the conflicting findings.

**Visuo-spatial abilities.** Research on the association between obesity and visuo-spatial ability is sparse. Taking all published studies together only three studies exist to date. Liang et al. (2013) included two studies that indicated an inverse relationship between child obesity and visuo-spatial skills. However, Veena et al. (2013) reported that being obese and higher adiposity measures are associated with higher visuo-spatial abilities in 540 children living in South India. The country-context might explain inconsistent findings similar as for the above discussed cognitive domains. Studies indicating a negative association were conducted in high-income countries (USA and Germany) while a positive relationship was found in a low-income country (India). Obesity may represent an advantageous nutritional status associated with better cognitive outcomes when the prevalence of underweight in the country exceeds the prevalence of overweight and obesity.

In summary, findings of studies investigating the relationship between childhood obesity and cognitive function suggest that some aspects of executive function (inhibition control, impulsivity, planning), attention and visuo-spatial abilities were lower in overweight or obese children compared to normal weight children living in middle to high-income countries while the evidence on other executive function

skills (e.g. reasoning), short and long-term memory performance, and general intelligence scores was inconsistent.

Comparing findings between studies can be challenging and conclusions should be drawn with caution, particularly given that different sub-facets of these cognitive abilities may have been assessed in different studies (e.g. memory: short term vs long-term; attention: selective vs focused; executive function: inhibition vs planning). Moreover, conclusions are based on the assumption that the test batteries used to assess these cognitive functions solely measure the cognitive domain that they are designed to measure. A clear distinction between cognitive domains can be difficult since a certain cognitive ability may require accessing of other cognitive domains (Diamond, 2013). Different domains of executive functions and attentions are intertwined. For example, inhibitory control requires working memory performance (holding information in mind and transform or integrate it) to decide on relevant or irrelevant (to inhibit) matters. Likewise, inhibitory control can be supportive in working memory performance as it suppresses irrelevant ideas or helps to resist focusing on single information. Keeping information in mind requires focused, selective attention. Therefore, working memory and selective attention are closely related and improvement in selective attention was shown to be associated with improved working memory (Chan et al., 2008; Diamond, 2013). Since some cognitive domains are overlapping comparison and interpretation of cognitive outcomes might be influenced by the fact that study authors use varying definitions of the cognitive abilities tested.

Further insight into the relationship between childhood obesity and cognitive function and its underlying mechanisms can be obtained from brain imaging and neuroelectric indices studies. In general, the frontal cortex of the brain is associated with cognitive control and the orbitofrontal cortex of the brain is associated with response inhibition control (Casey et al., 2005; Paus, 2005; Ridderinkhof et al., 2004; Rolls, 2004). A study comparing the grey matter volume of the orbitofrontal cortex of 81 adolescents indicated that obese adolescents (N = 45) had significantly lower grey matter volume compared to lean youth (N = 36) (Maayan et al., 2011).



Researchers stated that lower brain volume is associated with impaired cognitive functioning. Yau et al. (2012) compared brain (hippocampal) volumes, amount of brain cerebrospinal fluid, and microstructural integrity in major white matter tracts of age-matched obese youth with (N = 59, aged 14-20 years) and without (N = 34) metabolic syndrome. Findings suggested a significantly smaller brain volume, increased cerebrospinal fluid (due to brain volume loss) and reduced microstructural integrity of white matter in the group with metabolic syndrome (Yau et al., 2012). The researchers identified the presence of insulin resistance as the main predictor of the above findings. However, since insulin resistance was not associated with cognitive function and academic achievement in this study, Yau et al. (2012) postulated that obesity may be associated with lower cognitive function but structural changes in the brain occur only with metabolic dysfunctions. Yokum et al. (2012) suggested similarly referring to findings on lower grey matter volume in obese high school students (N= 17) compared to normal weight youth (N = 31) but there was no difference in grey matter volume between overweight (N = 36) and normal weight youth (Yokum et al., 2012). Obesity associated metabolic changes, less prevalent in overweight adolescents, were assumed to be the underlying reason for the findings.

Kamijo et al. (2012) measured the neuroelectric potential of brain regions associated with inhibition control in normal weight (N = 37) and obese (N = 37) pre-adolescent children during performance of a task measuring inhibitory control (Go/No Go test). Researchers postulated that neuroelectric indices related to low inhibitory control was significantly higher in obese children compared to normal weight children (Kamijo et al., 2012b)

To date, no further brain imaging or neuroelectric indices studies in children and youth have been published. More research is required to fully understand the association between childhood obesity and brain structure and function.

Synthesis of the published literature demonstrated a lack of longitudinal studies. Therefore little can be concluded about a causal relationship between child obesity and cognitive function. Bidirectional causality is theoretically feasible; being obese at a young age may have a negative impact on cognition and cognitive development and/or poor cognitive abilities may be a risk factor associated with the development

of obesity. The latter effect was strongly supported by four long-term prospective cohort studies from New Zealand (Belsky et al., 2013) and the UK (Chandola et al., 2006; Gale et al., 2009; Lawlor et al., 2006). Their findings demonstrated that low childhood cognitive abilities were associated with adult obesity. Belsky et al. (2013) also indicated that childhood obesity was not associated with a decline in cognitive function in adulthood. Adults who became obese over the years had already lower scores in cognitive function as a child than those who remained lean (Belsky et al., 2013). However, research suggested the predictive ability of childhood intelligence for adult adiposity might have been mediated by educational qualification obtained (Chandola et al., 2006; Lawlor et al., 2006) and dietary characteristics during adulthood (Chandola et al., 2006).

**Table 2.5: Association between child overweight and cognitive functioning**

Reference	Country/ study design	Sample characteristics	Adiposity measures	Cognitive function measures	Confounders/mediators	Statistical methods	Results
Belsky et al., 2013	New Zealand  Cross- sectional	N = 1,083 Age: 7-11y Sex: not reported OB: 41%	BMI <sup>a</sup>  Cut-offs based on CDC growth charts percentiles	Total IQ, Verbal IQ, Performance IQ, short-term memory, executive function  Wechsler Intelligence Scale for Children-Revised, Rey Auditory Verbal Learning Test, Trail Making Test	Birth weight, rate of weight gain during early childhood (0-3y), age and BMI at adiposity rebound, early childhood cognitive ability (Peabody Picture Vocabulary Test), parental education, income, parental height and weight	Multivariate regression	<ul style="list-style-type: none"> <li>• obese children obtained lower IQ, memory and executive function scores compared to lean peers (P&lt;.05 – memory, executive function, P&lt;.01- IQ scores)</li> </ul>
Fields et al., 2013	USA  Cross- sectional	N = 61 Age: 14-16y Sex: 56% (f) OW: 33% OB: 34%	BMI <sup>a</sup>  Cut-offs based on CDC growth charts percentiles	Impulsive-decision making, sustained attention, inhibition  Delay Discounting Task, Conner's continuous performance task II, Go/Stop Task	Income level, use of alcohol	Two-way ANOVA	<ul style="list-style-type: none"> <li>• OW+OB children had higher impulsivity scores than normal-weight peers (P&lt;.01)</li> <li>• higher inattention in OB youth compared to normal weight youth (P=.005) and OW youth ( P=.001), n.s difference between OW and normal weight youth</li> <li>• n.s. difference in inhibition 5scores between weight groups</li> </ul>

Table 2.5 (continued)

References	Country/ study design	Sample characteristics	Adiposity measure	Cognitive function measure	Confounders/mediators	Statistical methods	Results
Palermo and Dowd, 2012	USA  Cross-sectional	N = 2820 Age: 5-19y Sex: 50.0%(f) OW: 15% OB: 21%	BMI <sup>a</sup>  Cut-offs based on CDC growth charts percentiles	long-term memory, short-term memory, processing speed, auditory+ visual processing, comprehension-knowledge, fluid reasoning  Memory Digit Span test, Woodcock Johnson Revised Test of Achievement	Ethnicity, gender, age, parental education, SES, household income, survey year	ANOVA  Ordinary least Square regression (OLS)  Fixed effect analysis (FE)	<ul style="list-style-type: none"> <li>• OLS: negative association between OB (not OW) and applied problems scores (b=-1.7, P&lt;.05) and memory (b=0.6, P&lt;.01) in girls only</li> <li>• FE: n.s association between OW/OB and cognitive abilities</li> </ul>
Parisi et al., 2010	Italy  Cross-sectional	N = 422 Age: 6-13y Sex: 51% (f) OW:25% OB: 16%	BMI <sup>a</sup>  National growth curves OW=BMI85th-95 <sup>th</sup> centile, OB=BMI>95 <sup>th</sup> centile	Total intelligence, verbal intelligence, performance intelligence (conceptualizing, planning, problem solving, decision making) , attention, perception organisation, verbal comprehension  Wechsler Intelligence Scale for Children, revised	Gender, parental education score	Independent t-test  ANOVA  Linear regression	<ul style="list-style-type: none"> <li>• lower performance intelligence (P&lt;.01) and attention (P&lt;.05) scores in OB compared to normal-weight children</li> <li>• BMI significantly predicted performance intelligence ( =-.2, P&lt;.05)</li> </ul>
Ruiz et al., 2010	Spain  Cross-sectional	N = 1820 Age: 13-18y Sex:53% (f) OW: not reported	BMI <sup>a</sup>  Cut-offs based on IOTF classification	Reasoning, verbal and numeric ability  SRA Test of Educational Ability	Age, pubertal status, SES, family structure	ANCOVA  Logistic regression  Effect size (Cohen d)	<ul style="list-style-type: none"> <li>• n.s. association between BMI and cognitive performance</li> </ul>

Table 2.5 (continued)

Reference	Country/ study design	Sample characteristics	Adiposity measures	Cognitive function measures	Confounders/mediators	Statistical methods	Results
Sandjaja et al., 2013	Indonesia, Malaysia, Thailand, Vietnam  Cross-Sectional	N = 6,746 Age: 6-12y Sex: 50.6% (f)	BMI <sup>a</sup> z-scores  WHO growth reference charts	Non-verbal intelligence  Raven's Progressive Matrices Test of Non-Verbal Intelligence, 3 <sup>rd</sup> edition	Age, gender, urban/rural residency, maternal education level	Logistic regression	<ul style="list-style-type: none"> <li>• negative association between OW &amp; OB and IQ in Malaysia (OR below average IQ: OW 1.59 [95%CI 1.58-1.61], OB 1.70 [95%CI 1.69-1.72], severely OB 2.22 [95%CI 2.19-2.25])</li> <li>• negative association between severely OB and IQ in Thailand (below average IQ OR 1.04 [95%CI 1.02-1.06]) and Vietnam (below average IQ OR 1.42 [95%CI 1.40-1.45])</li> </ul>
Veena et al., 2013	South India  Cross-sectional	N = 540 Age: 9 - 10y Sex: 51.2% OW/OB: 3.5%	BMI <sup>a</sup>  WHO growth reference charts  Skinfold thickness  Waist circumference (WC)  %BF (BIA)	Long-term retrieval/learning, short-term memory, reasoning, verbal abilities and visuo-spatial abilities <sup>#</sup> , attention and concentration*  Kaufman's Assessment Battery for Children (2 <sup>nd</sup> edition) <sup>#</sup> Kohs block design, *Wechsler Intelligence Scale for Children, 3 <sup>rd</sup> edition	Gender, age, SES, parental education, occupation and income	Multiple linear regression	<ul style="list-style-type: none"> <li>• OW/OB obtained higher scores in reasoning ( <math>\beta</math> =0.46) and verbal ability ( <math>\beta</math> =0.56) compared to non-OW/OB (P&lt;.05)</li> <li>• positive association between BMI, WC, skinfold thickness and %BF and long-term-retrieval, reasoning, verbal ability</li> </ul>

Table 2.5 (continued)

Reference	Country/ study design	Sample characteristics	Adiposity measures	Cognitive function measures	Confounders/mediators	Statistical methods	Results
Veldwijk et al., 2011	The Netherlands  Prospective cohort study	N = 236 Age: 7y Sex:45% OWat 4y: 8% OW at 7y: 10%	BMI <sup>a</sup>  Cut-offs based on IOTF classification  BMI z-scores  Based on Dutch reference population	Sequential (short-term memory) and simultaneous processing  Kaufman Assessment Battery for Children	Gender, Physical fitness, maternal education & intelligence, maternal age at child birth, maternal pre-pregnancy BMI, maternal smoking during pregnancy, birth weight, breast feeding duration	Uni- and multivariate linear regression	• n.s. association between BMI and cognitive ability
Wong et al., 2007	Singapore  Case-Control (matched by age, gender, academic achievement level)	N = 105 Age: 13-18y Sex: not reported OB:45%	BMI <sup>a</sup>  Cut-offs based on IOTF classification  Waist circumference	Short-term memory  Rey Auditory Verbal Learning Test	None reported	Independent t-test  univariate ANOVA	• lower word recall scores and total learning scores in OB compared to normal-weight youth (P<.001)

f: female, OW: overweight, OB: obese, BMI: Body mass index, <sup>a</sup>: measured weight and height <sup>b</sup>: self/parental reported weight and height, BF: body fat, BIA: Bioelectric impedance analysis, IOTF: International Obesity Task Force, IQ: intelligence quotient, WHO: World Health Organisation, SES: socio-economic status, ANOVA: analysis of variance, ANCOVA: analysis of covariance, n.s.: non-significant (P>.05)

## **2.3. Association between childhood/youth obesity and ‘future success’**

Future success herein relates to a broad range of variables including: number of years of schooling, school completion, destination after leaving secondary/high school (e.g. vocational school, high school, and college enrolment/degree), employment status, type of employment, and adult wages/income. Research indicates that educational attainment has an independent and dominating impact on an individual’s social status attainment (Baker et al., 2012). Particularly in the economic literature, the association between overweight/obesity in childhood and adolescence, educational attainment and subsequent later life achievement is of vast interest. A low level of academic achievement in overweight or obese pupils might influence their choices for further education and subsequent employment opportunities. In addition, increased body fatness at young age has been shown to persist into adulthood (Serdula et al., 1993; Singh et al., 2008). A considerable body of literature indicates that obese adults tend to have lower employment rates and lower average income compared with non-obese adults (Han et al., 2011).

Literature was identified through the systematic literature search on childhood obesity and educational attainment (Chapter 2.1.) as well as by examining the reference list of relevant studies. Study characteristics and results are summarised in Table 2.6. Relevant studies (N=16) provided evidence from different developed countries over the past 20 years. Studies were conducted in the USA (N = 10), Italy (N = 1), South Korea (N = 1), Finland (N = 1), Denmark (N = 1) and the UK (N = 2) and were published between 1993 and 2013. Four studies are of cross-sectional nature (Barone & O'Higgins, 2010; Do & Finkelstein, 2011; Falkner et al., 2001; Fuxa & Fulkerson, 2011; MacCann & Roberts, 2013); 11 studies analysed longitudinal data with a mean follow-up of 12 years (range: 6 – 26 years). Studies investigated a variety of “future success” variables including years of schooling (four studies), school completion (six studies), enrolment in/completion of higher

education (seven studies), income (seven studies), and employment status (four studies).

Overall, all studies, including a total of 297,915 adolescents, consistently concluded that youth overweight or obesity is associated with reduced future success compared to normal weight peers. Evidence on specific 'future success' variables is described in the following paragraphs.

**Years of schooling.** Gortmaker and colleagues' (1993) findings indicated that obese female youth had significantly less schooling by 0.3 years (3.6 months) compared to normal weight peers (Gortmaker et al., 1993). This result was consistent with findings from Han et al. (2011). Lower years of schooling among obese youth was confirmed by Sargent and Blanchflower (1994) referring to longitudinal data from the UK. In contrast to Gortmaker et al. and Han et al., Sargent and Blanchflower also found a significant negative relation between obesity and years of schooling in males (Sargent & Blanchflower, 1994). However, a further two prospective cohort studies suggested no significant association for both males and females (Fowler-Brown et al., 2010; Viner & Cole, 2005). Differences in findings might be explainable through the higher proportion (25%) of obese adolescents in the study population of Sargent and Blanchflower ( $N_{\text{total}}=12,537$ ), identified by objective measurements of body weight and height opposed to a proportion of obese youth of 3% ( $N_{\text{total}}=10,039$ ), 9% ( $N_{\text{total}}=8,427$ ), and 18% ( $N_{\text{total}}=1,974$ ), respectively, where weight and height were self-reported (Fowler-Brown et al., 2010; Gortmaker et al., 1993; Han et al., 2011). Underestimation of obesity prevalence and subsequent lower sample size might have affected statistical power for detection of significant results. Difference in findings between the two British cohort studies (Sargent & Blanchflower, 1994; Viner & Cole, 2005) might be due to different effects of pre-adolescent obesity at 10 years (Viner & Cole, 2005) on length of schooling than adolescent obesity at 16 years (Sargent & Blanchflower, 1994) being close to the transition from secondary school to post-secondary education. Nevertheless, despite methodological differences, it might also be possible that there is no consistent relationship between



childhood obesity and years of schooling and that the relationship varies across population groups or individuals.

**School completion.** Evidence from two cross-sectional studies indicated that being overweight or obese during adolescence (N = 10,721) is positively associated with early school leaving (Barone & O'Higgins, 2010; Falkner et al., 2001). The risk of quitting school prematurely was higher in obese girls than in overweight or obese boys (Barone & O'Higgins, 2010). A significant relationship between the expectations to leave school earlier and obesity was found in boys but not in girls (Falkner et al., 2001). Okunade et al. (2011) explored the relation between on-time high school graduation and youth obesity. Findings of this single study (N = 8,388) indicated that overweight and obese girls are significantly less likely to graduate from high school on time. There was no significant evidence of delayed high school completion in overweight or obese boys (Okunade et al., 2009). Do and Finkelstein (2011) investigated whether body weight status is related to enrolment in vocational or general high school (N = 142,783). They found that the chance to enrol in vocational high school was significantly higher in obese youth but not overweight youth compared to normal-weight adolescents. This association was found to be stronger in girls than in boys (Do & Finkelstein, 2011). Winding et al. (2013) investigated the association between increased body weight status and educational attainment after compulsory school in 2,548 adolescents. Their findings indicated that overweight youth were 3.5 times more likely never to attain secondary education (high or vocational school) compared to normal weight peers (Winding et al., 2013). However, there was no significant evidence that overweight youth differ from normal weight youth in terms of attrition or still being in high school or vocational school (Winding et al., 2013). No other study investigated the association between body weight status and secondary school leaver destination to date.

**Enrolment in /completion of higher education.** A survey including 76,161 adolescents aged 14 years and 17 years suggested that overweight and obese boys and girls are less likely to enrol for college education compared to normal-weight peers (Fuxa & Fulkerson, 2011). The likelihood was lowest in obese girls (OR 0.5),

followed by overweight girls (OR 0.7), obese boys (OR 0.7), and overweight boys (OR 0.8) (Fuxa & Fulkerson, 2011). Crosnoe (2007) suggested that obese girls but not boys were significantly less likely to enrol in college by 50% (Add Health study, N=10,829) (Crosnoe, 2007). Similarly, Falkner et al.'s findings (2001) suggested that expectations not to finish college are significantly higher in obese youth compared to non-obese peers with higher expectations not to complete college education in obese girls than in obese boys (Falkner et al., 2001). Data from the National Longitudinal Survey of Youth 1997 (N=8,427) indicated that obese students had significantly a 39% lower chance to obtain a college degree compared to normal-weight youth (Fowler-Brown et al., 2010). Evidence for overweight youth was not significant. Comparing average grades obtained during the course of college or university education in 1036 adolescents, findings suggested that overweight and obese students received lower grades compared to healthy weight students after controlling for ability, personality and well-being (MacCann & Roberts, 2013). Two further longitudinal studies, on the other hand, found no significant association between overweight/obesity and college completion (Gortmaker et al., 1993; Sargent & Blanchflower, 1994). Analysis of data from early cohort compared to contemporary cohorts might explain differences in findings. Fowler-Brown et al.'s (2010) also non-significant results on the relation between obesity and college degree attainment from the earlier cohort from 1979, the same cohort used by Gortmarker et al. (1993). This might suggest that in recent years obese youth face stronger difficulties to enter college or attain a degree in higher education.

**Income.** Findings from a cross-sectional study on the association between overweight/obesity and adolescents' expectations to earn a middle income by the age of 30 years were not significant (Falkner et al., 2001). On the contrary, evidence from six longitudinal studies suggested that youth overweight and obesity is significantly negatively associated with household income (Gortmaker et al., 1993; Laitinen et al., 2002), annual income (Viner & Cole, 2005) and hourly earnings (Han et al., 2011; Sabia & Rees, 2012; Sargent & Blanchflower, 1994). All studies concluded consistently that the negative association between obesity and income is only present in females and not in males. In terms of magnitude, results are also

fairly consistent. At a 5% significance level obese adolescents earned 9.8% (Sabia & Rees, 2012), 8.6% (Han et al., 2011) and 7.4% (Sargent & Blanchflower, 1994) less than normal-weight peers. Sargent and Banchflower's (1994) results suggested a dose-response relationship; that is severely obese teenage girls (BMI > 99<sup>th</sup> percentile relative to the 1990 UK population) had even more reduced hourly earnings by 11.4%. Viner and Cole suggested that females with persistent obesity from youth into adulthood earned significantly less than normal-weight peers and had a higher risk of not being employed in gainful occupations (Viner & Cole, 2005). However, the relation to income did not remain significant after adjusting for confounding variables. Taking BMI into consideration, increase of BMI by one unit was significantly associated with 0.5% (Han et al., 2011) and 0.8% (Sabia & Rees, 2012) lower earnings. Laitinen and colleagues (2002) concluded that the negative association between youth adiposity and household income was mediated through low levels of education. Gortmarker et al. (1993) also pointed out that obese adolescent girls had 10% higher levels of household poverty as young adults compared to normal-weight peers.

**Employment status.** Three studies have investigated the association between teenage overweight/obesity and unemployment to date. There was no statistically significant association between increased body weight status at 10 years (N= 8,490), 14 years (N=9,754) and 16 years (N=12,537) and unemployment at 30 years (Viner & Cole, 2005), 31 years (Laitinen et al., 2002) and 23 years (Sargent & Blanchflower, 1994), respectively. Merten et al. (2008) explored the association between youth obesity and adult status attainment which included full-time employment, completed high school or Bachelor's degree and job satisfaction using 7 years follow-up data. Findings indicated that adolescence obesity is significantly associated with 13% lower status attainment (for definition see Table 2.6) in girls and that adolescent obesity explained variations in status attainment by 10% (Merten et al., 2008). No significant association was found in males.

In summary, the current available body of literature on the association between adolescent overweight/obesity and future success indicated consistently that

increased body weight status in girls could reduce the chances of educational attainment related future success but might not be associated with risk of unemployment. It was found that obese female teenagers had fewer years of schooling and lower income compared to normal-weight peers. Evidence on school completion is limited with direct findings from cross-sectional studies only indicating an early school leaving by obese adolescents. There were inconsistent findings regarding the negative association between youth obesity and enrolment in higher education. Being obese and to a lesser degree being overweight are, to some extent, associated with lower future success. However, it should be acknowledged that in many studies, body fatness predicted only a small amount of the variance in future success outcomes. Interestingly, compared to girls, being overweight or obese did not seem to be as negatively associated with a boy's later life achievements.

Lower employment status and income of individuals who were overweight or obese during adolescence might be directly influenced by years of schooling, school completion status and completion of higher education. Adolescents increased body weight status is associated with lower years of schooling and premature school leaving which is likely to determine occupation choice toward lower income occupations or even unemployment (Han et al., 2011). Findings on the inverse association between adolescent obesity and years of schooling/school completion might be explained by higher incidences of depressive symptoms in this population group (Marmorstein et al., 2014; Puder & Munsch, 2010). Depressive symptoms are associated with lower educational attainment, early school leaving and lower social status attainment (Fletcher, 2010; Merten et al., 2008). However, in the literature, a frequently discussed mechanism to explain the inverse association between adolescent obesity and future success are body weight related stigmatisation and prejudice toward obese individual's school and work performance. It was reported that overweight and obese pupils experience weight related stigmatisation from teachers and peers and later at working age this population group is viewed by employers and colleagues as less qualified, emotionally instable, not able to work in a team and frequently ill which prevents them from getting jobs, higher wages and promotions (Puhl & King, 2013).

The majority of reviewed studies on this topic were longitudinal cohort studies with a mean follow-up of 12 years which is arguably sufficiently long enough to detect changes in educational attainment-related later life achievements in adolescents. Studies provided data from large populations, employed adequate statistical analyses and accounted for a large number of confounding variables (see Table 2.6), thus the associations might be independent of population age, gender, cognitive ability, parental education, household socio-economic status or community heterogeneity. Therefore, the evidence on overall future success is strong and robust. However, only a small number of studies for each future success variable are currently available. The reliability of evidence might also be reduced due to primarily self-reported adiposity and future success measures which are known to introduce bias of underestimation and overestimation, respectively. Additional long term follow-up cohort studies using objectively measured means of overweight/obesity and future success are needed, which also include potential mediating variables, particularly to study the relationship between adolescent obesity, school completion and enrolment in higher education. This will add to our knowledge and understanding of the relationship between youth obesity and reduced income since available results suggest a mediating role of educational variables on income.

As indicated in section 2.1. and 2.2. on childhood obesity, educational attainment and cognitive function, evidence from observational studies does not inform about causality, i.e. whether increased body weight status causes lower future success, in female adolescents particularly. However, causality and its direction are of importance for policy makers and practitioners to implement effective interventions. In Chapter 3 I will therefore explore the evidence from controlled experimental studies on future success of overweight or obese children and adolescents.

**Table 2.6: Association between childhood overweight/obesity and future success**

Reference	Location	Sample characteristics	Adiposity measures	Later life achievement measures	Confounders/mediators	Statistical methods	Results
Baron and O'Higgins, 2010  Survey of school age adolescents in the province of Salerno	Italy	N = 778 Age: 14-17y Sex: 44% (f) OW or OB: 38% (f), 21% (m) OB: 5% (f), 3% (m)	BMI <sup>b</sup>  Cut-offs based on IOTF classification	Early school leaving  Self-reported	Family income, parental employment, complete family unit, maternal education, parental attention to child development, chronic health problems, previous educational attainment, relationship to school, lifestyle (smoking, sport, reading, cinema), local characteristics (e.g. unemployment rate)	Ordered prohibit model	<ul style="list-style-type: none"> <li>• OB in girls is associated with early school leaving by 95% (P&lt;.01)</li> <li>• OW in boys is associated with early school leaving by 40% (P&lt;.01)</li> <li>• n.s. coefficient on OW in girls and OB in boys</li> </ul>
Crosnoe, 2007  The National Longitudinal Study of Adolescent Health (Add Health)	USA	N = 10,829 Age: 13-17y (baseline), 20-24y (follow-up) Sex: 53% (f) OB baseline: 9.3% (f), 13.6% (m)	BMI <sup>b</sup>  Cut-offs based on CDC growth charts percentiles (2002)	College enrolment	Ethnicity, cognitive ability, athletic status, social relationships, parental education, family structure, school characteristics, school obesity prevalence,	Logistic regression	<ul style="list-style-type: none"> <li>• OB girls were 50% less likely to enrol in college (P&lt;.001)</li> <li>• n.s in OB boys</li> </ul>
Do and Finkelstein, 2011  Korean Youth Health Risk Behaviour Online Survey 2006/07	South Korea	N = 142 783 Age: 13-18y Sex: 47.6 (f) OW: 9.1% OB: 4.2%	BMI <sup>b</sup>  Cut-offs based on Korean CDC and Prevention Criteria growth charts percentiles	Secondary school leaver destination  Self-reported (vocational or general high school)	parents' education level, household economic status, number of cars, no own bedroom, number of computers at home, residential area type, survey year	Ordered prohibit regression analysis	<ul style="list-style-type: none"> <li>• likelihood of vocational high school enrolment versus general high in obese males 8.6% points and in females 10.6% points higher than in normal weight students</li> <li>• n.s. for OW males and females</li> </ul>

Table 2.6 (continued)

Reference	Location	Sample characteristics	Adiposity measures	Later life achievement measures	Confounders/mediators	Statistical methods	Results
Falkner et al., 2001	USA	N = 9943 Age: 12-16y Sex: 52.3% (f) OW: 12.2% OB: 6.1%	BMI <sup>b</sup>  Cutoff values from NHANES I	Quitting school, expected college completion, work success expected, middle income by age 30 expected  Self-reported	Grade level, ethnicity, SES (parental education, occupation status)	Univariate analysis  Logistic regression analysis	<ul style="list-style-type: none"> <li>• sig. relation between OB and expectation to quit school only in boys (<math>\chi^2=20.3</math>, <math>P&lt;.001</math>)</li> <li>• OW/OB boys are 1.5/2 times more likely to quit school than normal-weight (CI 95% 1.07-2.22/CI 95% 1.45-3.30)</li> <li>• Expectation not to finish college greatest in OB girls (<math>\chi^2=37.2</math>, <math>p&lt;.001</math>) and OB boys (<math>\chi^2=19.2</math>, <math>P&lt;.001</math>)</li> </ul>
Fowler-Brown et al., 2010	USA	N = 8,427 Age at baseline: 17y (cohort '79), 15y (cohort '97) Age at follow up: 43y (cohort '79), 23y (cohort '97) Sex: 48% (f) OW: 10.2% (cohort '79), 13% (cohort '97) OB: 3.3% (cohort '79), 9.7% (cohort '97)	BMI <sup>b</sup>  Cut-offs based on CDC growth charts percentiles (2000)	Attainment of Bachelor's degree, number of years of schooling,  Self-reported	Age, sex ethnicity, height, parental educational, parental income-to-poverty, participant aptitude test scores, rural residence	Multivariable generalised linear equations using Poisson regression  Multivariable linear regression analysis	<ul style="list-style-type: none"> <li>• OB students (cohort '97 only) had 39% lower chance to have college degree compared to normal weight peers (95% CI 0.38-0.83; <math>P</math> for trend <math>&lt;.005</math>)</li> <li>• n.s. association between OW/OB and years of schooling</li> </ul>

Table 2.6 (continued)

Reference	Location	Sample characteristics	Adiposity measures	Later life achievement measures	Confounders/mediators	Statistical methods	Results
Fuxa & Fulkerson, 2011	USA	N = 76,161 Age: 14y, 17y Sex: 50.6%(f)	BMI <sup>b</sup>	Collage enrolment	Grade in school, ethnicity, living situation, region, free or reduced-price lunch	Logistic regression analysis	• in OW likelihood to plan to go to college: OR 0.8 (m), OR 0.7 (f)
Minnesota Student Survey		OW: 13% OB: 9%	Cut-offs based on CDC growth charts percentiles (2009)	Self-reported			• in OB likelihood to plan to go to college: OR 0.7 (m), OR 0.5 (f)
Gortmaker et al., 1993	USA	N = 10,039 Age: 16-24y at baseline, 23-31y at follow up Sex: 51% (f)	BMI <sup>b</sup>	Years of schooling, college completion, Household income	Household income, educational level, parental education, intelligence, chronic physical health conditions, height, self-esteem, age, ethnicity	Multivariate regression	• OB in women is associated with 3.6 fewer month of schooling compared to normal weight women (95% CI 1.2-7.2 month, P<.01)
National Longitudinal Survey of Labor Market Experience, Youth Cohort (NLSY)		OW: 13% OB: 3%	Cutoff values from NHANESI	Self-reported			• OW and OB in women is associated with lower household income compared to normal weight women (P<.001)
							• n.s. association in men and for college completion



Table 2.6 (continued)

Reference	Location	Sample characteristics	Adiposity measures	Later life achievement measures	Confounders/ mediators	Statistical methods	Results
Han et al., 2011  National Longitudinal Survey of Youth 1979	USA	N = 1,974 Age: 14-22y at baseline, 30-34y at follow-up Sex: 45.9% (f) OB: f - 8% (baseline), 24% (follow-up); m – 18% (baseline), 22% (follow-up)	BMI <sup>b</sup>  OB = BMI > 30 kg/m <sup>2</sup>	Wages, highest education level, occupation outcomes  Self-reported	Labour market characteristics, state-level macroeconomic conditions, age, ethnicity, marital status siblings, education level, number of children, elapsed time from latest pregnancy, self-esteem, height, aptitude test scores, years of employment, on-the-job training, parental education	Ordinary Least Square regression analysis  Multilevel fixed effect model  Multinomial logit model	<ul style="list-style-type: none"> <li>• 1 unit of BMI is associated with of hourly wages by 0.51% in women only (P&lt;.1)</li> <li>• OB at 14-22y is associated with 8.6% lower wages in women only (P&lt;.05)</li> <li>• OB at 14-22y is associated with 0.35 years less schooling in women (P&lt;.05)</li> </ul>
Laitinen et al., 2002  Northern Finland Birth Cohort 1966	Finland	N = 9,754 Age: 14y (baseline), 31y (follow-up) Sex: 52% (f) OW: 10.8% (baseline) OB: 5.0% (baseline)	BMI <sup>b</sup> (at age 14y)  Cut-offs based on internal definition: OW 85 <sup>th</sup> percentile, OB 95 <sup>th</sup> percentile	Unemployment at 31 years  register data of Social Insurance Institution or self-reported  Household income at 31y  Self-reported	Family social class at 14 years, place of residence at 14 years, school performance at 16 y, size and composition of household	Cross-tabulation using Pearson's Chi square test  Binary logistic regression analysis	<ul style="list-style-type: none"> <li>• n.s. negative association between OW/OB at 14y and unemployment at 31y</li> <li>• negative association between OW/OB in girls aged 14y with household income (P=.006) – n.s after adjustment for school performance</li> <li>• n.s. risk of unemployment when OW/OB at 14y</li> </ul>

Table 2.6 (continued)

Reference	Location	Sample characteristics	Adiposity measures	Later life achievement measures	Confounders/mediators	Statistical methods	Results
MacCann and Roberts, 2013	USA	N = 1,036 Age: 15-85y Sex: 64% (f) OW: 25% OB: 21%	BMI <sup>b</sup>	Average grades in university or collage	Gender, SES, ethnicity, geographical region, attitude towards school, Contentiousness	ANCOVA, partial correlation, Cohen's <i>d</i>	<ul style="list-style-type: none"> <li>• lower grades in OW/OB university and college students compared to normal-weight peers (college ES: OW 0.3, OB 0.4; university ES: OB 0.3; <math>P &lt; .05</math>)</li> </ul>
Merten et al., 2008  National Longitudinal Study of Adolescent Health (Add Health)	USA	N=7,881 Age: 12-18y (baseline), 19-26y (follow-up) Sex: 52% (f) OB: 16%  Follow-up: 7 years	BMI <sup>b</sup>  Cut-offs based on CDC growth charts percentiles (2000)	Young adult status attainment: Full-time employment or full-time college student, job satisfaction, seeking higher education degree, completed high school or bachelor's degree  Self-reported	Gender, ethnicity,	Multilevel model	<ul style="list-style-type: none"> <li>• 13% lower status attainment in young female adults when OB youth (<math>P &lt; .01</math>)</li> <li>• 10% of variation in adult status attainment explained by youth OB</li> <li>• persistent OB associated with 7% lower status attainment compared to non-OB in youth and adulthood (<math>P &lt; .01</math>)</li> </ul>
Okunade et al., 2009  The National Longitudinal Study of Adolescent Health (Add Health)	USA	N = 8,388 Age: 12-15y Sex: 53% (f) OW: 18.5% OB: 8.7%	BMI <sup>b</sup>  Cut-offs based on IOTF classification	On-time high school graduation	Academic ability (GPA, Picture Vocabulary Test), ethnicity, mother's education, lifestyle (smoking, TV use, computer use, alcohol, relationship, sport), gender, family characteristics, region (rural/urban)	Probit regression analysis  Propensity score matching	<ul style="list-style-type: none"> <li>• OW and OB in females lowers likelihood of on-time high school graduation by 2.5% and 5% respectively (<math>P &lt; .05</math>)</li> <li>• n.s. results for males</li> <li>• matching method confirms regression results</li> </ul>

Table 2.6 (continued)

Reference	Location	Sample characteristics	Adiposity measures	Later life achievement measures	Confounders/mediators	Statistical methods	Results
Sabia and Rees, 2012  The National Longitudinal Study of Adolescent Health (Add Health)	USA	N = 12,445 Age: 11-19y at baseline, 24-32y at follow-up Sex: 50% (f)	BMI <sup>a</sup>  OW = BMI > 25-30 kg/m <sup>2</sup> OB = BMI > 30 kg/m <sup>2</sup>	Wages per hour	Age, marital status, number of children, academic ability (Peabody Picture and Vocabulary Test), highest grade completed, years at current job, parental education, household income at baseline, current school enrolment, part-time job, occupation indicators, urbanicity	Ordinary least square test (OLS)  Fixed effect model (FE)  Two-Stage least square estimation (2SLS) using sibling BMI and mothers BMI as instrument	<ul style="list-style-type: none"> <li>• OLS: one unit in BMI and being OW/OB is associated with a 0.8-10% in wages of white women (P&lt;.01); being OW male is associated with a 6.5 - 20% in wages (P&lt;.01)</li> <li>• FE: one unit in BMI and being OW is associated with a 1-9% in wages of white women (P&lt;.01); one unit in BMI and being OB is associated with a 2% and 26%, respectively, in wages of black men (P&lt;.01)</li> <li>• 2SLS: one unit in BMI is associated with a 1.9% and 0.31% in wages of white women using mothers BMI and sibling BMI, respectively (P&lt;.01, P&lt;.05)</li> </ul>

Table 2.6 (continued)

Reference	Location	Sample characteristics	Adiposity measures	Later life achievement measures	Confounders/mediators	Statistical methods	Results
Sargent and Banchflower, 1994	UK	N = 12, 537 Age: 11y, 16y at baseline, 23 at follow-up Sex: OB baseline: 23% (f), 25% (m) OB follow-up: 26% (f), 27% (m)  National Child Development Study (NCDS)	BMI <sup>a</sup>  OB 90 <sup>th</sup> percentile	Years of schooling, college completion, hourly wages, employment status	Country employment rate, type of industry, marital status, highest education level, plant size, part-time employment, union membership, ethnicity,	Independent t-test  Ordinary least square regression	<ul style="list-style-type: none"> <li>• OB males (<math>P &lt; .01</math>) and females (<math>P &lt; .001</math>) at age 16y had fewer years of schooling than non-OB, n.s. for college education and part-time employment</li> <li>• being OB at 11y and 16y is associated with 3.5% and 7.4%, respectively, earnings compared to non-OB women only (<math>P &lt; .05</math>)</li> <li>• being severely obese (BMI &gt; 99<sup>th</sup> percentile) at 16y is associated with 11.4% earnings compared to non-OB women only (<math>P &lt; .05</math>)</li> </ul>

Table 2.6 (continued)

Reference	Location	Sample characteristics	Adiposity measures	Later life achievement measures	Confounders/mediators	Statistical methods	Results
Viner and Cole, 2005	UK	N = 8,490 Age: 10y (baseline), 30y (follow-up) Sex: 52% (f) OB: 4.3% (baseline), 16.3% (follow-up)  1970 British Cohort study (BCS70)	BMI <sup>a</sup> (baseline) OB 95 <sup>th</sup> percentile (UK 1990 growth reference)	Years of schooling, employment status, occupation type, income	Height at 10y and 30y, parental BMI z scores, maternal education, social class, cognitive ability at age 10y	Multivariable models using logistic regression	<ul style="list-style-type: none"> <li>• persistent OB is associated with higher risk to be never gainfully employed (OR 1.9, 95%CI 1.1-3.3, P=.06)</li> <li>• sig. negative association between OB and income in females only when unadjusted for SES and parental BMI z-scores</li> <li>• n.s. association between obesity and years of schooling, unemployment</li> </ul>
Winding et al., 2013		N = 2,548 Age: 14-15y (baseline), 20-21y (follow-up) Sex: OW:10.6%	BMI <sup>b</sup>  Cut-offs based on IOTF classification	Educational attainment after compulsory school (Completion/attainment/ attrition/ non-attainment of high school or vocational school)	Gender, age at 9 <sup>th</sup> grade, family income, family situation, parental education, school performance (Danish, maths), general health, depressive symptoms, self-esteem, sense of coherence	Multinomial logistic regression	<ul style="list-style-type: none"> <li>• OW is associated with never attaining secondary education compared to being at normal weight (OR 3.4, 95% CI 1.4-8.6)</li> <li>• n.s. association between OW/OB and attrition of or being in secondary education</li> </ul>

f: females, m: males OW: overweight, OB: obese, BMI<sup>b</sup>: self-reported body mass index, IOTF: International Obesity Task Force, NHANES I: First National Health and Nutrition Examination Survey (USA), n.s.: non-significant (P>.05)

## **2.4. Potential confounding and mediating factors explaining the association between childhood obesity, educational attainment and associated outcomes**

A child's body weight seems to explain only a small amount of the variation in educational attainment, cognitive function and future success. Additionally, the negative association between obesity and these outcomes was often found to be weak after adjusting for confounding and mediating variables, suggesting that part of the relationship between overweight/obesity and attainment outcomes may be indirect. By definition, mediating factors are suspected to play a role in the hypothesised causal relationship between exposure and outcome variables, whereas confounding factors are not on a causal pathway between exposure and outcome (MacKinnon et al., 2007). For example, low SES and parental education are confounding variables and not mediators because child obesity does not cause low SES and parental education which then acts inversely on child's educational attainment. In contrast, ill-health is a mediator since child obesity is often associated with ill-health which in turn is associated with impaired academic and cognitive performance. Investigation of whether a variable has mediating properties requires three conditions, i) the explanatory variable for body weight status needs to be associated with the response variables educational attainment, cognitive function or future success, ii) body weight status must be associated with the suspected mediating variable, and iii) the mediating variable must be associated with educational attainment, cognitive function or future success. Figure 2.3 illustrates the most commonly discussed confounding and mediating variables examined in the association between childhood obesity and low educational attainment.

### **Confounding and/or mediating variables**

Confounding and/or mediating variables typically considered in studies exploring the relationship between child obesity and educational attainment and associated achievements include, but are not limited to, child's age, gender, ethnicity, socio-

economic status, birth weight, whether the child was breastfed, prenatal conditions, parenting style, and obesity-related pathophysiological, psychosocial and lifestyle factors. As reviewed in Chapter 2.2 cognitive function can also be considered as a mediating variable since child obesity is associated with lower cognitive ability for some cognitive domains and cognitive skills are associated with educational attainment. Therefore, I will not include cognitive function in this section and refer the reader to Chapter 2.2.

**Demographic factors.** The prevalence of overweight and obesity is higher in older children and adolescents compared to younger children; with the highest prevalence in adolescence. (Bromley et al., 2013; NHS, 2010; Ogden et al., 2012). Due to its natural developmental nature, cognitive function and educational attainment is more advanced in older children compared to younger children (Waber et al., 2007). The Scottish Health Survey from 2012, the National Health and Examination Survey from 2009-2010 (USA) and other health surveys (e.g. Germany, Japan) reported higher levels of overweight and obesity among boys compared to girls (Bromley et al., 2013; Ogden et al., 2012). In terms of education, although critically debated to date, research indicates a gender difference toward better attainment in girls than in boys (Deary et al., 2007). Higher obesity prevalence is also present in ethnic minorities. In the USA the obesity prevalence was higher among non-Hispanic black and Hispanic children and adolescents than among non-Hispanic white youth (Ogden et al., 2012). Data from the Millennium Cohort Study, a prospective cohort study of British children born in 2000, indicated that children of Pakistani, Bangladeshi or Black ethnicity showed a statistically significantly higher prevalence of obesity than White children (Connelly, 2011). The survey also found that children from lower socio-economic background showed a significantly higher overweight and obesity prevalence than children from managerial or professional households (Connelly, 2011). On the other hand, educational attainment gaps were also reported for ethnic minorities and socially disadvantaged children (Connolly, 2006).

**Early life factors.** There are early life factors such as prenatal conditions, birth weight, and feeding practice that are associated with both development of overweight

and obesity and cognitive and academic development. In terms of prenatal conditions, children of mothers who smoked during pregnancy were more likely to be overweight and obese (Beyerlein et al., 2010; Connelly, 2011; Reilly et al., 2005) and obtain lower educational attainment scores (Härkönen et al., 2012). Increased birth weight is also associated with increased prevalence of overweight and obesity in later childhood (Reilly et al., 2005) as well as with reduced verbal and non-verbal intelligence and reading and mathematics skills (Corbett et al., 2007). In contrast, lower than average birth weight is associated with poor cognitive and educational outcomes (Corbett et al., 2007; Shenkin et al., 2004). Although it is widely suspected that breastfeeding has a protective effect on the development of child overweight and obesity, recent systematic review evidence concluded that there is no convincing evidence to support the assumed beneficial effect of breastfeeding on children's body weight (Casazza et al., 2013; Lefebvre & John, 2013). However, several studies have demonstrated that, compared to bottle fed children, breastfed children obtained better cognitive ability scores after controlling for maternal intelligence and other confounding factors (Anderson et al., 1999). Parenting practice and motivation were shown to have a considerable influence on child's early year's cognitive development (Glascoe & Leew, 2010; Keels, 2009; Lugo-Gil & Tamis-LeMonda, 2008).

**Pathophysiological factors.** Child and youth obesity is associated with comorbidities such as hypertension, impaired insulin sensitivity, and metabolic syndrome (Daniels, 2009; Reilly et al., 2003) which were shown to be inversely related to cognitive function and educational attainment. Lande et al. (2012) conducted a case-control study on cognitive function of children with (N = 22) and without (N = 25) hypertension. Children were matched on age, sex, ethnicity, intelligence quotient, maternal education, household income, and body weight status. Executive function using the Behavior Rating Inventory of Executive Function was measured at baseline in both groups of children. Children with hypertension received an antihypertension therapy for 12 months. Follow-up assessment indicated that executive function scores improved in the hypertensive group after therapy but not in the control group (Lande et al., 2012). Yau et al. (2012) matched 49 adolescents who



were diagnosed with metabolic syndrome with 62 adolescents without metabolic syndrome on age, socioeconomic status, school grade, gender, and ethnicity. Researchers evaluated participants' intellectual abilities (using Wechsler Abbreviated Scale of Intelligence), executive function (using Wisconsin Card Sorting Test, Tower of London Test, Controlled Oral Word Association Test, and Trails B Test), attention (using Digit Vigilance Test and Wide Range Achievement Test Attention-Concentration Index), and academic achievement (using Wide Range Achievement Test). Findings indicated that adolescents with metabolic syndrome had significantly lower attention, mental flexibility, mathematics, and spelling scores compared to peers without metabolic syndrome (Yau et al., 2012).

Obesity-related health problems may also cause overweight and obese children to miss school more often. Pan et al. (2013) assessed the association between obesity-related health conditions and parental reported health-related school absenteeism in 3,470 adolescents (aged 12-17 years). Researchers concluded that after controlling for socio-demographic and health factors (e.g. age, sex, ethnicity, maternal education level, ADHD, respiratory allergy, allergies) overweight and obese adolescents had 36% and 37% more absent days in school per year, respectively, compared to normal-weight children (Pan et al., 2013). Higher levels of school absenteeism were associated with lower performance in school (Baxter et al., 2011; Gottfried, 2011).

Other pathophysiological factors mediating the obesity-attainment relation might be sleep deprivation and interrupted sleep. Child and youth obesity are associated with shorter sleep duration (Cappuccio et al., 2008; Chen et al., 2008) and interrupted sleep due to obesity related disordered breathing (obstructive sleep apnea) (Daniels, 2009). After controlling for gender, ethnicity, socioeconomic status, and school night sleep duration, Beebe et al. (2010) indicated that with increasing severity of sleep disordered breathing, overweight and obese children (N = 163, age 10-17 years) experience greater attention and learning difficulties (Beebe et al., 2010). Tan et al. (2012) studied 31 adolescents (age 10-18 years) with and without obstructive sleep disorders and suggested that, after controlling for age, intelligence and BMI-z-scores, self-reported school problems were significantly higher in youth with compared to those without obstructive sleep disorder (Tan et al., 2013). Another

study assessed the association between daytime sleepiness in 2,210 children and adolescents aged 9-17 years (60% overweight) and mathematics and languages attainment obtained from school records (Perez-Chada et al., 2009). Findings indicated that higher scores in daytime sleepiness increased significantly the odds of failing language and mathematics test by 5% and 4%, respectively after controlling for age, gender, sleeping hours during the week and weekend, and BMI. Only one study evaluated the mediating relationship between child obesity, sleep disordered breathing and cognitive function (Spruyt & Gozal, 2012). Using the Differential Ability Scale, Spruyt and Gozal (2012) assessed verbal and non-verbal reasoning, general cognitive abilities, and spatial conceptual abilities in 351 children aged 6-10 years. The researchers applied structural equation modelling and reported that one third of the effect of increased BMI on lower cognitive performance was ascribed to sleep disordered breathing (Spruyt & Gozal, 2012).

**Psychosocial factors.** In comparison to normal weight children and youth, overweight and obese peers experience more often psychosocial distress through weight related teasing, discrimination and social isolation which can result in impaired self-esteem, self-efficacy, quality of life and depression (Brixval et al., 2011; Danielsen et al., 2012; Griffiths et al., 2010; McClure et al., 2010; Puhl & Latner, 2007). Overweight-related teasing and social rejection are associated with low school performance in overweight or obese children. Krukowski et al. (2009) reported that weight-related teasing increased the risk of self-reported poor school performance by 55% in 1,071 children aged 4-13 years (Krukowski et al., 2009). Additionally, the negative association between overweight and school performance became non-significant after including weight-related teasing into the statistical model suggesting a mediating effect of teasing. Gunnarsdottir et al. (2012) included 84 obese children aged 7-13 years in their weight management programme. Researchers assessed the association between obesity, teacher-reported educational attainment and social rejection at baseline and indicated that after controlling for gender, parental education, parental depression, parental life-stress, and physical activity teasing/social rejection was a strong significant contributor to explain 36% of the variability in low academic performance (Gunnarsdottir et al., 2012a). In their systematic literature review (discussed in detail in Chapter 2.1.1) Caird et al. (2011)

concluded that psychosocial effects of overweight and obesity are suspected to mediate the inverse association between overweight and school performance (Caird et al., 2011). Using structural equation models, Kristjansson et al. (2010) indicated that self-esteem obtained from the Rosenberg Self-Esteem Scale had a strong and direct relationship with self-reported educational attainment in 5,810 adolescents aged 14-15 years (Kristjansson et al., 2010). To date, only one study investigated the extent to which psychosocial mediating variables attributed to the variation in academic achievement in overweight and obese children (Gable et al., 2012). Using data from a prospective cohort study (follow-up 6 years), Gable et al. (2012) assessed interpersonal skills and internalizing behaviour in 6,250 children aged 5 years at baseline. Researchers reported a small but statistically significant mediation effect of interpersonal skills (teacher assessed) in girls with persistent overweight over time and later onset of overweight. The mediation effect grew stronger with increasing age. Furthermore, internalizing behaviour such as anxiety, sadness, and loneliness showed a mediation effect between obesity and academic achievement that was slightly higher in older girls than boys (Gable et al., 2012).

Overweight and obese children and adolescents who experience psychosocial distress may be more likely to miss school (Kearney, 2008) which is associated with lower educational attainment (Baxter et al., 2011; Gottfried, 2011). Controlling for age, ethnicity and gender, Geier et al. (2007) suggested that obese children missed more days in school compared to normal-weight peers ( $N = 1,069$ , age:  $11.15 \pm 1.0$ ) (Geier et al., 2007). Rappaport et al. (2011) included 165,056 children from grade 1 to 12 (age 6-20 years) in their study and their findings indicated that compared to normal-weight children, obese children and severely obese children miss school more often by 4% and 11%, respectively (Rappaport et al., 2011). Another study found no significant difference in school attendance between overweight or obese and normal-weight pupils ( $N = 920$ , age 9-10 years) (Baxter et al., 2011). Neither of the studies explored the reason for school absenteeism. A higher number of absent school days might be related to both psychological and somatic conditions. Therefore, the link between increased psychosocial distress and increased school absenteeism in overweight and obese children and youth is under-investigated. However, since psychosocial distress is associated with increased school absenteeism

in the general population it seems plausible that adverse psychosocial factors contribute to school absenteeism and therefore lower educational attainment in overweight and obese pupils.

**Lifestyle-related factors.** Research showed that overweight and obese children and adolescents are more likely to be engaged in health behaviours that are associated with lower cognitive functions and educational attainment.

Systematic review evidence of 12 cross-sectional and two longitudinal studies suggested consistently that overweight and obese adolescents (aged 11-19 years) are less physically active and fit than their normal weight counterparts (Rauner et al., 2013). Some of the reviewed studies in Chapter 2.1.1 suggested a mediating effect of decreased physical fitness (Roberts et al., 2010; Van Dusen et al., 2011) on the obesity-attainment association. There is a large body of literature indicating that physically active and fit children obtain better cognitive tasks and school attainment scores compared to inactive and unfit peers. Sibley and Etnier (2003) conducted a systematic review and meta-analysis which included 37 correlational or cross-sectional studies of which 25 studies assessed the association between overall physical fitness and academic or cognitive achievement and 11 studies assessed motor ability in relation to academic or cognitive achievement. Researchers reported a significant effect size of 0.35 (standard deviation 0.33) for children aged 4-18 years (Sibley & Etnier, 2003). This finding was confirmed by Fedewa and Ahn (2011) who also conducted a systematic review and meta-analysis on this topic. The statistically significant effect size of 20 cross-sectional studies was 0.32 (standard error 0.03, 95% CI 0.26 – 0.37) in children aged 4-19 years (Fedewa & Ahn, 2011). Another systematic review included prospective cohort studies only (10 studies) conducted in children and adolescents aged 6-18 years (Singh et al., 2012). Researchers also concluded that being more physically active (self-reported) is associated with improved cognitive (measured) and academic performance (self-reported and measured).

Development of primary childhood obesity is caused by an imbalance between energy intake and energy expenditure in the way that energy intake (diet) exceeds energy expenditure (physical activity). Frequent consumption of high-calorie

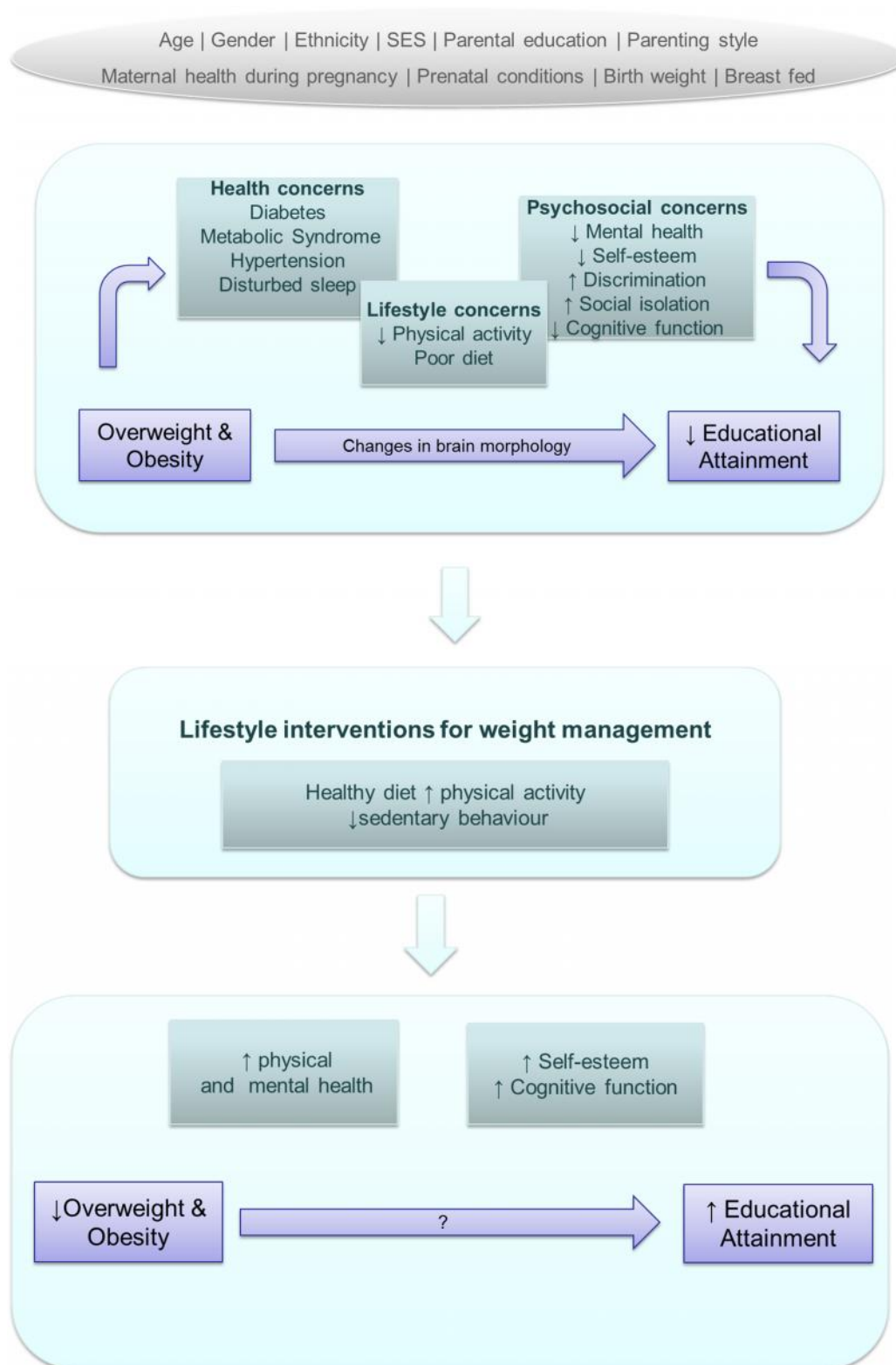
food and soft drinks might moderate the association between overweight and academic achievement (Li & O'Connell, 2012). A mediating effect of diet and dietary habits appears to be plausible given that a considerable body of literature exists suggesting that a healthy diet is associated with improved cognitive and educational attainment scores and that a poor diet is associated with lower achievement scores. Kristjansson et al. (2010) suggested that high intake of “junk food” (potato chips, crisps, hamburger) was negatively associated with self-reported academic attainment, whereas intake of fruit and vegetables had a direct positive relationship with academic attainment in 5,810 adolescents aged 14-15 years (Kristjansson et al., 2010). Florence et al. (2008) also assessed the association between diet quality and reading and writing attainment in 4,589 children aged 10-11 years. Applying multilevel modelling and controlling for a range of confounding variables, the researchers indicated that children who reported to consume a high quality diet (high fruit and vegetable intake and lower calorie intake) were 30% less likely to fail in reading and writing tests (Florence et al., 2008). Drinking less than 12 ounces of sweetened beverages per day (self-reported) was associated with higher mathematics and reading scores compared to higher intake of sweetened beverages in 800 children aged 11 years (Edwards et al., 2011). The same researchers reported a positive relationship between self-reported consumption of 100% fruit juice twice per day and having breakfast on at least five days per week on mathematics and reading attainment. The variability of school attainment attributable to lower intake of sweetened beverages and higher intake of 100% fruit juice and breakfast was 7-11% (Edwards et al., 2011). Evidence of a beneficial association between breakfast consumption and cognitive function and educational attainment were reported to be inconsistent (Rampersaud, 2009). In contrast, four studies included in a systematic review concluded consistently that healthy breakfast consumption is positively associated with school performance (Hoyland et al., 2009). Moreover, a quasi-experimental study conducted in 10 obese children aged 9-10 years suggested that attention (Conners' Continuous Performance Test II) and memory (Test of Memory and Learning) scores were lower before breakfast consumption indicating that skipping breakfast could have inverse effects on cognitive performance (Maffeis et al., 2012). Riggs et al. (2012) reported that self-reported snacking was statistically

significantly negatively associated with executive function scores (assessed using the Behavioral Rating Inventory of Executive Function) and positively associated with self-reported fruit and vegetable intake (N = 1,587; age 11 years) (Riggs et al., 2012). Assessing the association between consumption of different food groups and general intelligence, Theodore et al. (2009) indicated that eating bread or cereals less than four times/day was associated with reduced intelligence scores by 4 points (Stanford Binet Intelligence Scale, 4<sup>th</sup> edition) at age 3.5 years but not at 7 years (N = 591) (Theodore et al., 2009). In contrast, consumption of fish only once per week was associated with decreased intelligence scores by 4 points (Wechsler Intelligence Scale for Children, 3rd edition) at age 7 years but not at 3.5 years (Theodore et al., 2009). De Groot et al. (2012) reported that adolescents (age 12-18 years, N = 600) who met the recommended amount of fish intake obtained better vocabulary scores (Amsterdam Vocabulary Test) than those whose intake lies below the recommendations (de Groot et al., 2012). Longitudinal data from the UK ALSPAC cohort suggested that high fat and sugar diets in preschool children (N = 3,966; age 3-4 years) was associated with decreased intelligence (assessed by using Wechsler Intelligence Scale for Children) and school performance in mathematics, reading and writing (key stage 1 and 2 National tests) at primary school age (Feinstein et al., 2008; Northstone et al., 2011).

In summary, the inverse association between childhood obesity and educational attainment, cognitive function and later life achievements might be confounded and/or mediated by demographic, early life, obesity-related pathophysiological, psychosocial and/or lifestyle factors. Given the complexity of obesity development and academic achievement more research is needed to identify mediating variables and their influence in the causal pathway between obesity and educational attainment.

Reducing pathophysiological and psychosocial stress associated with child obesity and improving physical activity levels, diet and healthy lifestyle habits could have beneficial effects on cognitive function and educational attainment in overweight and obese children and adolescent.

In the following chapter the evidence on how lifestyle interventions for weight management might work to benefit cognitive function and educational attainment will be reviewed. First, I reviewed the literature on the effect of lifestyle interventions in the general population while outlining plausible mechanisms of action. In the second part I discussed why lifestyle interventions can work differently in overweight or obese children and adolescents.



**Figure 2.3: Confounding and/or mediating factors and potential causal links in the association between childhood obesity and educational attainment based on the literature reviewed.**



## **2.5. Lifestyle interventions for improvement of educational attainment and associated achievements**

A lifestyle intervention aims to modify a person's way of living, by changing patterns of behaviour which are harmful to health, in order to improve it (WHO, 1998). A lifestyle intervention for obese people targets dietary habits, physical activity, sedentary behaviour, and behaviour change. Clinical guidelines for the prevention and treatment of childhood obesity from countries such as from the UK (NICE, 2013; SIGN, 2010), Australia (NHMRC, 2003), Canada (Lau et al., 2007), and Malaysia (Ismail et al., 2004) recommend a multicomponent approach combining;

- reduced energy intake
- increased physical activity ( 60 min/day, moderate-to-vigorous intensity)
- decreased sedentary behaviour (for example: screen time < 2 hours/day)
- behaviour change techniques (for example: goal setting, self-monitoring, self-regulation).

A high quality systematic review and meta-analysis (Cochrane review) concluded that lifestyle interventions aiming to alter eating and sedentary behaviour and physical activity pattern in a family-based setting were effective in achieving clinically meaningful weight reduction (Oude Luttikhuis et al., 2009).

Growing evidence has shown that the influence of lifestyle interventions, particularly physical activity and dietary intervention lie beyond the alteration of the global energy balance. Many aspects of diet and physical activity have been demonstrated to benefit cognition and educational attainment health (Dauncey, 2009; Dishman et al., 2006; Gomez-Pinilla, 2011; Hillman et al., 2009).

### **2.5.1. How the interventions might work in the general child and adolescent population**

Multicomponent lifestyle interventions may benefit cognitive function and school achievement in the general child and adolescent population, i.e. a study population including normal weight and overweight or obese children and adolescents. For

example, after implementation of an uncontrolled intervention involving healthy nutrition, physical activity and behaviour change techniques in a US primary school, there was an upward trend in reading performance scores which exceeded the national average by 10% after 8 years (Nansel et al., 2009). Another before/after study implementing a healthy diet (free breakfast) and physical activity (10-20 minutes teacher-led) programme in a primary school reported an increase in children passing the standardised tests in writing, reading and mathematics by 25%, 27%, and 31%, respectively (Sibley et al., 2008). A similar but controlled school-based intervention promoting healthy eating and physical activity behaviour in children aged 11-14 years through an educational programme demonstrated a significant improvement of mathematics, listening and speaking scores after only 5 weeks compared to the control condition (standard classroom education (Shilts et al., 2009).

These studies demonstrated that targeting more than one lifestyle aspect can have beneficial effect on children's educational attainment. However, each component of a lifestyle intervention may offer separate, plausible mechanisms of action.

### **Dietary modification**

In a controlled experimental study, Belot and James (2011) evaluated the effect of changes in school meals toward healthier options over a period of three years (Jamie Oliver's "Feed me better" campaign) on Key stage 2 National educational attainment of primary schoolers aged 11 years (N ~ 80,000) in mathematics, English and science (Belot & James, 2011). Findings indicated that the proportion of children who met or exceeded the recommended attainment level increased by 3% points in mathematics, 3-6% points in English, and 2-8% points in science in intervention schools compared to control schools (Belot & James, 2011).

A systematic review on the effect of breakfast interventions on cognitive function in school aged children suggested that eating breakfast had beneficial effects on memory (14 studies) and attention (22 studies) performance compared to the control condition (no breakfast) (Hoyland et al., 2009). Implementation of breakfast programmes in schools showed beneficial effects on mathematics performance (14 studies). The researchers pointed out that this effect might be due to increased

attendance associated with the provision of school breakfast clubs rather than the improved diet per se. Nine studies evaluated the effect of different types of breakfasts on cognitive outcomes with findings suggesting no conclusive evidence (Hoyland et al., 2009). Another systematic literature review by Ells et al. (2008) included 29 studies on the effect of breakfast consumption (15 studies), sugar intake (six studies), fish oil (five studies) and vitamin supplementation (two studies), and healthy diets (one study) on cognition and educational attainment. Ells et al. (2008) concluded that there was insufficient evidence to suggest a beneficial effect of breakfast and sugar interventions, vitamin supplementation, and healthy diets on children's cognitive and educational outcomes. Ells et al. (2008) conclusion on the effect of vitamins on child's cognition was confirmed by another recent in-depth review (Nyaradi et al., 2013). However, emerging evidence for positive effects of certain fatty acids, particularly long-chain omega-3-fatty acids abundant in oily fish, on cognitive function and educational attainment was postulated (Ells et al., 2008; Kuratko et al., 2013).

Potential mechanisms underlying effects of diet on cognition and educational attainment refer to the ability of dietary components to modify levels of neurotrophic and neuroendocrine factors involved in learning and memory and levels of oxidative stress on synaptic membranes in the brain. Neurotrophic and neuroendocrine factors are known to regulate brain function include brain-derived neurotrophic factor (BDNF), insulin-like growth factor 1 (IGF-1) and glucocorticoids (Dauncey, 2009). These factors activate cell signalling systems connected to transcription of genes involved in neuroplasticity, neurogenesis, and survival of neurons. Animal experimental studies indicated that ingestion of a diet rich in saturated fatty acids and simple sugars, characteristics of "junk foods" and typical Western diets, reduce levels of BDNF which had detrimental effects on memory performance and learning (Gomez-Pinilla, 2008; Kanoski & Davidson, 2011; Woo et al., 2013). High sugar diets are associated with reduced insulin sensitivity or insulin resistance. The latter is known to reduce vascular reactivity in general and in the brain which then might impair brain structures and cognitive function (Yates et al., 2012). High fat diets were also associated with increased oxidative cellular stress and lipid peroxidation of

synaptic membranes (Park et al., 2010). In contrast, a diet rich in omega-3-fatty acids, which are components of neuronal membranes, was found to increase levels of neurotrophic and neuroendocrine factors and reduces oxidative stress in the brain. Omega-3-fatty acids are suspected to improve cognitive abilities by facilitative synaptic plasticity and membrane fluidity (Dauncey, 2009; Gomez-Pinilla, 2008). There is emerging evidence that consumption of a diet rich in antioxidants, found in fruit and vegetables, can also reduce oxidative stress in the brain and therefore protect synaptic membranes from lipid peroxidation and other membrane damaging compounds (e.g. free radicals) (Gomez-Pinilla, 2008).

Some research also indicated that exposure to high fat and sugar diets and its impact on memory and learning leads in turn to uncontrolled food intake and subsequent weight gain (Davidson et al., 2005; Kanoski & Davidson, 2011). All studies proposing a mechanistic explanation for beneficial effects of dietary components were conducted in adults or animal models. Therefore, at present, it is unclear whether the same mechanisms occur in children and adolescents.

In summary, dietary interventions that provide healthy diet, low in saturated fat and simple sugars and high in unsaturated fats, complex carbohydrates, fruits and vegetables may play a beneficial role in improving the cognitive function and educational attainment of children and adolescents.

### **Increased physical activity**

Literature synthesising the large body of publications on the effect of physical activity on cognitive function and educational attainment consistently concluded that physical activity can improve cognitive and academic outcomes. A meta-analysis of 16 RCTs of various chronic and acute physical activity interventions (e.g. aerobic exercise, physical education, resistance training) suggested an estimated effect size of 0.29 units (SD = 0.24,  $P < 0.05$ ) (Sibley & Etnier, 2003). Another meta-analysis of 39 experimental and quasi-experimental studies by Fedewa and Ahn (2011) included various physical activity interventions as well as intervention trials on the effect of physical fitness on cognitive abilities and educational attainment (Fedewa & Ahn, 2011). Researchers indicated an overall effect size of 0.35 units (SE = 0.04, 95% CI

0.27 to 0.43). A systematic review which assessed the evidence on school-based physical activity interventions (32 studies) concluded that they may enhance both cognitive and school performance (CDC, 2010). Finally, the most recent systematic review of RCTs on aerobic physical activity indicated, based on four included studies, that interventions improved cognitive and educational performance (Lees & Hopkins, 2013).

Physical activity and fitness may act on cognition and educational attainment through various mechanistic pathways. There are physiological mechanisms (elevated blood circulation, increased levels of neurotrophins and neurotransmitters; Dishman 2006), learning/developmental mechanisms (children's movement experience stimulates processing of other concepts; Piaget 1956) and psychosocial mechanisms (Eime et al., 2013).

In animal models and humans, physical activity was shown to impact on brain neuronal plasticity underlying cognitive ability primarily of higher cognitive processes such as executive function. Research suggested that aerobic exercise increased levels of neurotrophic factors, particularly the brain derived neurotrophic factor (BDNF) associated with synaptic plasticity and survival of neurons (Dishman et al., 2006; Knaepen et al., 2010). Chaddock et al. (2010) studied 49 higher and lower-fit preadolescent children and evaluated the volume of specific brain areas (hippocampus) in relation to memory performance scores. Researchers noted that lower-fit children had smaller brain volumes and obtained lower cognitive task scores compared to higher-fit children (Chaddock et al., 2010). Besides modifying brain volume, physical activity and physical fitness may also affect neuroelectric brain activity as studied using event related brain potential (ERP) in children. Findings indicated that physically active children showed better allocation of cognitive processes involved in stimulus engagement and control during cognitive tests compared to less physically active children (Hillman et al., 2011). Research suggested that engagement in physical activity reverses the negative effects of high-fat diets on cognitive function in rats (Molteni et al., 2004; Woo et al., 2013). Calorie restriction and physical activity seems to have an additive effect on synaptic

plasticity in brain regions critical for memory and learning (Gomez-Pinilla, 2008; Stranahan & Mattson, 2008; Vaynman et al., 2006).

Beside positive effects on neurocognitive function, participation in physical activity was shown to benefit quality of life, self-esteem and mental health in children and adolescents as concluded by a systematic review of 30 studies (Eime et al., 2013). Psycho-social effects of increased physical activity may beneficially impact on motivation to learn, school attendance and educational attainment.

### **Reduced sedentary behaviour**

A sedentary lifestyle in children, particularly television viewing 2 hours/day, is associated with the development of overweight or obesity (review of 71 studies) (Rey-Lopez et al., 2008) and lower educational attainment. Longitudinal data indicated that children (aged under three years) with low television exposure (< 3 hours per day) performed better than those with high television exposure (≥ 3 hours per day) in reading (N = 1031) and mathematics (N = 1797) (Peabody Individual Achievement Test) when at preschool age (Zimmerman & Christakis, 2005). Similarly, parent-reported television viewing in preschool children was inversely related to mathematics achievement when aged 10 years (N = 1314) (Pagani et al., 2010) and reading achievement when aged 10-12 years (N = 308) (Ennemoser & Schneider, 2007). Longer term educational outcomes may also be affected. Hancox et al. (2005) indicated that young people (N = 980; follow-up = 21 years) with the highest television viewing time during childhood and adolescence tended to have no formal educational qualifications and those with a university degree watched the least television (TV) during childhood and adolescence (Hancox et al., 2005). Television viewing ≥ 3 hours/day at age 14 years (N= 678) was associated with a 2-fold risk to fail to obtain a post-secondary school education when aged 33 years compared to those watching television < 1 hour/day, mediated by attention difficulties, frequent failure to complete homework, and negative attitudes about school at age 16 years (Johnson et al., 2007a). Increased attention problems were also noted by Landhius et al. (2007) who reported that every additional hour of TV viewing at the age of 5-11 years was associated with attention problems at 13 years and 15 years after controlling for gender, attention problems in early childhood,

cognitive ability at 5 years of age, and childhood socioeconomic status (Landhuis et al., 2007).

Increased time spent in sedentary activities such as TV viewing or video game playing may replace opportunities to engage in other activities that promote scholastic and cognitive development (e.g. doing homework, leisure-time reading) (Tremblay et al., 2011). Additionally, high levels of sedentary behaviour were associated with reduced self-esteem and intervention for reducing sedentary behaviour yielded in improved self-worth and self-esteem (Goldfield et al., 2007; Simon et al., 2004) which may mediate beneficial effect on cognitive and academic performance. Therefore reducing sedentary behaviour (TV and screen time) in obese or overweight children might improve cognitive function and educational attainment.

### **Behaviour modification**

Behaviour change techniques in overweight/obese children may foster the decision-making and self-control skills needed to increase energy expenditure (through physical activity) and reduce energy intake (Bruce 2011); these may also benefit studying and thus educational attainment.

The effect of multicomponent lifestyle interventions or their individual components on cognitive function and school achievement might be influenced by study design characteristics (for example: intervention type, dose and duration) and participant characteristics that determine physical and mental development and maturation (for example: age, gender, weight status).

In summary, there are numerous plausible mechanisms of actions by which lifestyle interventions could act, alone or in combination, to benefit cognitive function, educational attainment and future success with or without changes in body weight status (Figure 2.3.).

### **2.5.2. How the interventions might work in overweight and obese children and adolescents**

Since overweight and obesity are associated with poor cognitive function, school attainment and future success, lifestyle interventions that reduce overweight and obesity might also benefit cognitive function and school attainment. Potential mechanisms explaining how lifestyle interventions could benefit overweight and obese children differently from the general population build on the suggestive evidence from observational and experimental studies. These include neuro-cognitive, psychosocial, and pathophysiological mechanisms associated with the development and consequences of childhood obesity (Figure 2.3).

Research indicates that overweight and obese children show higher impulsivity and inattention and lower reward sensitivity, self-regulation and mental flexibility compared to normal-weight peers (Delgado-Rico et al., 2012b; Fields et al., 2013; Nederkoorn et al., 2006). These neuro-cognitive factors are associated with increased food intake and uncontrolled eating behaviour and thus assumed to be predictors of weight gain (Fields et al., 2013; Francis & Susman, 2009). Lifestyle interventions for weight management might positively impact on neuro-cognitive factors required for controlled food intake. A randomised controlled trial conducted with 44 overweight and obese children (age range 8 to 14 years) suggested that specific training of self-regulatory abilities improved weight loss maintenance after an in-patient weight loss programme in the intervention group compared to control group (Verbeken et al., 2013a). Findings from another randomised controlled overweight treatment programme involving 62 children (mean age  $10.3 \pm 1.1$  years) indicated an improvement of problem solving skills after an intervention duration of 6 months (Epstein et al., 2000). Inhibition control skills were improved in 42 obese adolescents aged 12 to 17 years after 12 weeks of cognitive behavioural therapy (Delgado-Rico et al., 2012b).

In comparison to normal weight children and youth, overweight and obese peers experience more frequent psychosocial distress through weight related teasing, discrimination and social isolation which can result in impaired self-esteem, self-



efficacy, quality of life and depression (Brixval et al., 2011; Danielsen et al., 2012; Griffiths et al., 2010; Puhl & Latner, 2007). Overweight-related teasing and social rejection are associated with low school performance in overweight or obese children (Gunnarsdottir et al., 2012a; Krukowski et al., 2009). Psychosocial effects of overweight and obesity are suspected to mediate the inverse association between overweight and school performance (Caird et al., 2011). Lifestyle interventions for paediatric overweight treatments might benefit school attainment through improvement of self-esteem, depressive symptoms and quality of life (Oude Luttikhuis et al., 2009; Pratt et al., 2013).

Child and youth obesity is associated with co-morbidities such as hypertension, impaired insulin sensitivity, and metabolic syndrome which are known to be inversely related to cognitive function and educational attainment (Lande et al., 2012; Yau et al., 2012). Health problems may also cause overweight and obese children to miss school more often (Pan et al., 2013); higher levels of school absenteeism are associated with lower performance in school (Gottfried, 2011). Research indicated that childhood obesity is also associated with sleep deprivation and disrupted sleep due to obesity-related disordered breathing (Chen et al., 2008; Spruyt & Gozal, 2012). Poor sleep reduced the ability of children to concentrate in school (Beebe et al., 2010) and this in turn impacts negatively on cognitive function and school attainment (Beebe et al., 2010; Perez-Chada et al., 2009; Spruyt & Gozal, 2012). Lifestyle intervention can improve health and reduce co-morbidities in children (Janssen & Leblanc, 2010; Oude Luttikhuis et al., 2009) and thus may benefit cognitive and educational outcomes.

Therefore lifestyle interventions for weight management could improve cognitive and school performance by reducing sources of metabolic and psychosocial stress and through improving neuro-cognitive abilities associated with weight gain. With increasing adiposity, the severity of neuro-cognitive, psychosocial and pathophysiological changes might increase and the benefit of lifestyle interventions for weight management on school, cognitive and later life outcomes might depend on the level of adiposity. Since lifestyle interventions may benefit cognitive function,

educational attainment and future success through different obesity-related pathways (Figure 2.2) it is plausible that overweight and obese children benefit more significantly from the effects of improved diet, physical activity and sedentary behaviour compared to normal weight children.

## **Chapter 3: Lifestyle Interventions for Improving School Achievement in Overweight or Obese Children and Adolescents (Cochrane Systematic Review)**

This section has been published in the *Cochrane Library* (Martin et al., 2014). The published review is not attached to the thesis because this chapter preserves the structure and content of the published review as far as possible.

### **Aim:**

To assess the efficacy of lifestyle interventions for weight management on school achievement, cognitive function and future success in overweight and obese children and adolescents.

### **3.2. Introduction**

In the 21st century the pace of knowledge production is vast. Synthesis of literature in various disciplines gives room to assess existing knowledge and to evaluate research or policy intervention accordingly. A large body of knowledge often confronts people with contradicting evidence. Synthesis and evaluation of existing knowledge can therefore facilitate decision-making and supports evidence-based practice. It also enables the researchers to develop and specify research questions needed to develop the existing body of knowledge further (Tranfield et al., 2003).

A Cochrane review is a systematic review of research in health care and health policy conducted under guidance and according to principles of the Cochrane Collaboration. The Cochrane Collaboration is an international organisation which prepares, maintains and promotes systematic reviews on the evidence of effects of health care. The principles of the Cochrane Collaboration include teamwork, avoiding duplications, reducing bias, keeping up to date, striving for relevance, promoting access and ensuring relevance (Higgins & Green, 2011). Cochrane

reviews aim to assist people in making well-informed decisions about health care and health policy by providing a reliable and reproducible synthesis of evidence on a particular topic (Higgins & Green, 2011). Once the review topic was accepted to be of relevance and has not been reviewed before, the Cochrane Review Group is responsible for preparing and maintaining the systematic review by supporting the authors and peer-reviewing the Cochrane review. This present Cochrane review was carried out in collaboration with the Cochrane Developmental, Psychosocial and Learning Problem Group.

### **3.2.1. Rational for conducting this systematic review**

The sources of evidence outlined in Chapter 2 are primarily based on observational data. This suggests firstly that the data are vulnerable to confounding even when some confounders are measured and accounted for, and secondly, that causal effects cannot be inferred. Reverse causation is also possible, whereby children with poorer baseline cognitive ability or educational attainment are more likely to be obese. However, these data do allow one to hypothesise that interventions that reduce body weight might have a range of additional benefits.

The current rising trend in childhood obesity (WHO, 2014) means that the prevalence of cognitive and educational problems among children is also likely to increase. Given the evidence of a link between low school attainment and economic disadvantage, this might have financial repercussions as regards future employability and income.

The beneficial effects of changes in diet, physical activity, sedentary behaviour, and thinking patterns for prevention and treatment of childhood obesity are well established (Oude Luttikhuis et al., 2009; Waters et al., 2011) and already part of clinical guidelines for the management of obesity (Ismail et al., 2004; Lau et al., 2007; NHMRC, 2003; NICE, 2013; SIGN, 2010). However, the extent to which these lifestyle interventions might also affect cognitive function, and subsequent school and later life attainment of overweight and obese children and adolescents remains unknown.

Drawing from neuro-cognitive, psychosocial, and pathophysiological aspects of causes and consequences of childhood obesity, lifestyle interventions for weight management might benefit overweight and obese children differently compared to normal weight children through modification of obesity-related conditions unlikely to be present in normal weight children (see Chapter 2.5).

It is important that not only researchers but government agencies, educationalists and parents/guardians work together to improve both children's physical and mental health. This systematic review is important as it may influence the way in which existing health promotion policies for schools are monitored and evaluated. This review will allow the likely extent of potential benefits, and the interventions most likely to yield benefits to be identified (i.e. effectiveness of interventions). It may emphasise a re-evaluation of policies and implementation of more effective interventions to increase pupils' development, health and well-being.

### **3.2.2. Aim and objective**

The aim and objective of this study was to assess whether lifestyle interventions (diet, physical activity, sedentary behaviour, and behavioural therapy) improve educational attainment, cognitive function and future success in overweight and/or obese children and adolescents.

## **3.3. Methods**

### **3.3.1. Criteria for selecting studies for this review**

*Types of studies.* Randomised controlled trials (RCT), cluster-randomised trials or controlled trials of lifestyle interventions with or without cross-over design were eligible for inclusion. For inclusion of cross-over trials, data of first iteration had to be obtainable.

***Types of participants.*** Overweight or obese children or adolescents aged three to 18 years attending preschool or school, and whose body weight status was determined using age- and gender-specific BMI percentiles, BMI z-scores, BMI standard deviations score (SDS), BMI cut-off points, or waist circumference. Classification of the weight status needed to be based on a relevant national or international reference population for inclusion.

Studies were not excluded based on the location. Children with medical conditions known to affect weight status and academic attainment such as Prader-Willi-Syndrome or diagnosed intellectual disabilities were excluded.

***Types of interventions.*** Studies were eligible for inclusion when the interventions aimed to prevent or reduce childhood obesity. For inclusion, interventions had to be lifestyle interventions of any frequency and duration provided in any setting that comprised one or more of the following;

- a) Interventions to increase physical activity (including exercise),
- b) Dietary and nutritional interventions (excluding supplements),
- c) Interventions to decrease sedentary behaviour/screen time/TV time
- d) Psychological interventions to facilitate weight management

Interventions could target children with or without participation of family members. Pharmacological and surgical interventions were excluded because these interventions are likely to be conducted in a less representative sample and thus limit generalisability.

Eligible control interventions were waiting list, attention control, no treatment or standard care.

***Types of outcome measures.*** Primary or secondary outcomes did not serve as criterion for selection of studies based on title and abstract. Assessment of outcome measures was a criterion for inclusion in this review when full texts were screened.

Outcome data were extracted at the end of the intervention and at any other follow-up time point.

- Primary outcomes:

*School achievement* (de Groot et al., 2010): recorded by appropriately trained investigators (for example: teachers, researchers). Participant or parent reported data will be excluded.

Overall school performance

- i average of school subject performance over one academic year, for example grade point average (GPA)

Individual subject performances

- i school subject percentage scores or standard achievement test scores for a) maths b) reading c) language
- ii validated tests for school achievement in the subjects a) maths b) reading c) language, for example Woodcock-Johnson III Tests of Achievement

Special educational classes

- i need of special educational class
- ii reduction of time allocated for special educational class

These primary outcomes were used for the ‘Summary of Findings’ table.

- Secondary outcomes:

*Cognitive function* (Carroll, 1993); Measures of general cognitive ability or different cognitive domains (for example: attention, memory, executive function) assessed using validated cognitive ability tests administered by appropriately trained investigators. Participant or parent reported data will be excluded.

*Future success* (Geddes et al., 2010); Including but not limited to, years of schooling, high school completion, enrolment in higher education, rates of full-time employment, monthly earnings, home ownership, receipt of social services.

*Obesity indices*; Age- and gender specific BMI, BMI z-scores and BMI-SDS when obtained from measured (not self-reported) weight and height, measured waist circumference, and measures of body fatness by dual energy X-ray absorptiometry (DXA) and bioelectrical impedance analysis (BIA). Studies reporting obesity indices will only be included when measures of school achievement, cognitive function and/or future success are also reported. Studies reporting obesity indices were only included when measures of school attainment, cognitive function, and/or future success were also reported. Inclusion of these data might enable the review authors to examine whether or not any changes in school performance, cognitive function, and/or future success variables occur independently of changes in obesity. Inclusion of obesity indices is not intended to examine the effect of lifestyle interventions on childhood obesity itself because this has already been examined in a Cochrane Review (Oude Luttikhuis et al., 2009).

### **3.3.2. Search methods for identification of studies**

The following electronic databases were searched in May 2013.

- Cochrane Central Register of Controlled Trials (CENTRAL), part of the Cochrane Library, 2013 Issue 4
- Ovid MEDLINE, 1950 to April Week 4 2013
- Embase, 1980 to Week 18 2013
- PsycINFO, 1806 to April Week 5 2013
- CINAHL Plus, 1937 to current
- MIT cognet
- ERIC, 1966 to current
- SPORTDiscus, 1980 to current
- International Bibliography of Social Science (IBSS), 1951 to current
- Conference Proceedings Citation Indexes (Web of Science), 1990 to 3 May 2013
- Cochrane Database of Systematic Reviews (CDSR), 2013 Issue 4
- Database of Reviews of Effectiveness (DARE), 2013 Issue 2



- Database on Obesity and Sedentary Behaviour Studies
- Database of Promoting Health Effectiveness Reviews (DoPHER)
- Bibliomap - Database of Health Promotion Research
- Trials Register of Promoting Health Interventions (TRoPHI)
- Current Controlled Trials (controlled-trials.com)
- WHO International Clinical Trial Registry (who.int/trialsearch)
- Networked Digital Library of Theses and Dissertations (ndltd.org)

The search strategy for Medline (ovid) is displayed in Appendix 8.2.1. Controlled vocabulary and syntaxes were modified as appropriate for the search in other databases. Reference lists of systematic reviews and other reviews from The Cochrane Library and the EPPI-Centre, the bibliographies and citations of included studies, and relevant guidelines were examined for eligible studies. Volumes 1 to 7 of The Journal of Human Capital were searched, which is not included the Cochrane Collaboration's handsearching list and is not comprehensively indexed by the databases searched.

Authors of included studies were contacted when outcome data were missing or further details on methodology were needed. Furthermore, authors were asked for new follow-up data that were not available when the study was published. Where necessary, we obtained translations of the title and abstract of non-English language studies. If the study appeared to be eligible for inclusion, we obtained the full article and a translation of the article for further assessment. Articles were translated from Chinese (Mandarin), Korean, Japanese, Spanish, and German.

### **3.3.3. Data collection and analysis**

*Selection of studies.* AM and DS independently screened the titles and abstracts to identify potentially relevant trials, and assess the full reports for eligibility. Different opinions about eligibility will be resolved by discussion, or where the authors did not agree the other authors (SS and JS) arbitrated. The reasons for excluding trials were recorded.

*Data extraction and management.* Two review authors (AM and DS) independently extracted data using a pre-defined data extraction form. Cross-checking of extracts

was performed to resolve discrepancies. The data extraction form included the following items:

- General information: date of data extraction, reviewer ID, title, published/unpublished, authors, year of publication, country, contact address, language of publication, source of study
- Eligibility criteria: study design, population, intervention, comparison
- Methods (including risk of bias assessment): study design, randomisation methods, allocation concealment, blinding, handling of missing data, selective data reporting
- Population: method and setting of recruitment, age, gender, ethnicity, inclusion/exclusion criteria, number of subjects recruited, included and followed (total and in comparison groups), diagnostic criteria of cognitive function and overweight/obesity, comparability of groups at baseline, co-morbidities
- Intervention: type(s), frequency, mode of delivery, intensity of physical activity, methods and timing of comparison of intervention, setting, intervention and follow-up duration, who delivered intervention, attrition rates, assessment of compliance, details of comparison/control
- Outcome: assessor characteristics, baseline measures, measures immediately after intervention and at follow-up, follow-up time points, validity of measurement tools, definition of outcome (for example: units, scales) primary outcome, secondary outcome
- Results: qualitative/quantitative data, continuous/dichotomous data, source, missing data, summary statistics for each group
- Analysis: statistical power, methods of analysis, adjustment for confounding

***Assessment of risk of bias in included studies.*** AM and DS independently assessed the risk of bias in each trial using the Cochrane Collaboration's tool for assessing risk of bias (Higgins & Green, 2011). Findings were cross-checked and discrepancies resolved through discussion. This included the assessment of selection bias (random sequence allocation and allocation concealment), performance bias (blinding of

participants and personnel), detection bias (blinding of outcome assessment and incomplete outcome data), reporting bias (selective reporting), and other sources of bias. The review authors judged the risk of bias as either 'high risk' of bias, 'low risk' of bias or 'unclear risk' of bias, using the information provided. We intended to resolve disagreements by discussion and, if necessary, we planned to contact the other review authors (SS and JS) for advice. No disagreement between AM and DS occurred.

***Measures of treatment effect.*** The difference in mean values was calculated or extracted, that is mean difference (MD), when continuous data, such as numerical marks, were measured on the same scale. When similar outcomes were measured on different scales, we calculated the standardised mean difference (SMD). When similar outcomes were measured on different scales, but were reported as change data by one study and as post-intervention data by another, we analysed the treatment effect by calculating the mean difference (Higgins & Green, 2011). Included studies did not provide dichotomous or ordinal data. However, in the Additional Methods table (Appendix 8.2.2), it is described how I intend to treat these types of data if available.

***Unit of analysis issues.*** We scanned all included studies with clustered randomisation of participants for the appropriate analysis of clustered data. For studies where the control of clustering was missing or insufficient, and individual participant data were not available, we approximately corrected the intervention effect of cluster-randomised trials using the approach of reducing the size of each trial to its 'effective sample size' (Higgins & Green, 2011). We planned to calculate the effective sample size in studies with dichotomous data presented as follows: number of participants and number of events divided by the 'design effect', which is  $[1 + (M-1) * ICC]$ , where M is the average cluster size and ICC is the intra-cluster correlation coefficient. When outcome measures were continuous, we divided the sample size by the design effect only. A sensitivity analysis was performed to determine the robustness of the conclusions from the meta-analyses that included cluster-randomised trials. When no ICC was reported, we used the ICC estimate of a

similar study. Based on raw data from (Ahamed et al., 2007), the ICC of 0.019 was calculated and used to estimate the effective sample size.

Cross-over trials were considered as eligible for inclusion if participants were randomised into the first period. It was planned to include data only from the first period in the analysis but none of the included studies were cross-over trials.

I conducted separate subgroup analyses for studies that compared the effect of a single intervention (for example, physical activity alone) to a control condition, separately from studies that compared a combination of any type and number of interventions of interest (for example, physical activity with dietary advice) to a control condition.

I planned to analyse data of studies which reported results at more than one time point in a separate meta-analysis with comparable data of other studies at similar time points, but none of the included studies provided outcomes at multiple time points; see Appendix 8.2.2.

***Dealing with missing data.*** Where possible, characteristics, reason for and number of missing data were reported for all included studies. Trial authors were contacted to obtain missing data. In the analysis I ignored data reported as ‘missing at random’. Where possible, missing values were imputed using the ‘last observation carried forward’ (LOCF) method in individual participant data. Although this approach of imputing missing data is prone to bias, in particular when carried forward measurements were taken not relatively recently (i.e., in studies with long follow-up time points) (Higgins & Green, 2011), this approach appeared most practical given that access to individual participant data was not available for all included studies that required imputation methods. Sensitivity analyses will be performed to examine the effects of including imputed data in meta-analyses.

***Assessment of heterogeneity.*** Clinical heterogeneity was assessed by comparing the similarity of included studies in terms of participants, interventions (type, duration, mode of delivery, setting), and outcomes. By comparing study design and risk of bias I evaluated methodological heterogeneity. Statistical heterogeneity across studies was assessed by visual inspection of the forest plot and we used the Chi<sup>2</sup> test with a

significance level of  $P < 0.1$ , due to its low power at detecting heterogeneity when studies are low in sample size and number of events (Higgins & Green, 2011). In addition, I determined the percentage of variability of intervention effect due to statistical heterogeneity among studies by calculating the  $I^2$  statistic. Variability of more than 50% may indicate moderate to substantial heterogeneity of intervention effects (Higgins & Green, 2011). Furthermore, the cause of heterogeneity was assessed by conducting subgroup and sensitivity analyses as described below.

***Assessment of reporting biases.*** It was planned to assess reporting bias by using funnel plots, but this was not possible due to insufficient numbers of included studies; see Appendix 8.2.2.

***Data synthesis.*** Review Manager 5.2 (RevMan, 2012) was used for data entry and analysis. Outcome data from included studies were combined in meta-analyses when the outcome measure addressed the same measurement concept (for example, school attainment) and used the same measurement scale (for example, Grade Point Average). It was planned to combine dichotomous and continuous data measuring the same outcome as recommended in chapter 9 of the Cochrane handbook (Higgins & Green, 2011), but this could not be done as all data from included studies were continuous.

Lifestyle intervention studies have inherent heterogeneity due to intervention implementation and setting, so the true intervention effect is likely to vary between studies. Therefore, data were pooled data using the random-effects model and effect sizes of studies that were inappropriate to include in a meta-analysis were provided.

***Subgroup analysis and investigation of heterogeneity.*** Subgroup analyses are principally intended to investigate sources of heterogeneity within a meta-analysis in relation to factors which potentially impact on outcomes. A number of potentially influential participant and intervention characteristics for subgroup analyses were identified. However, only one subgroup analysis due to the low number of included studies was performed; this analysis compared studies employing a multicomponent versus single-component interventions.

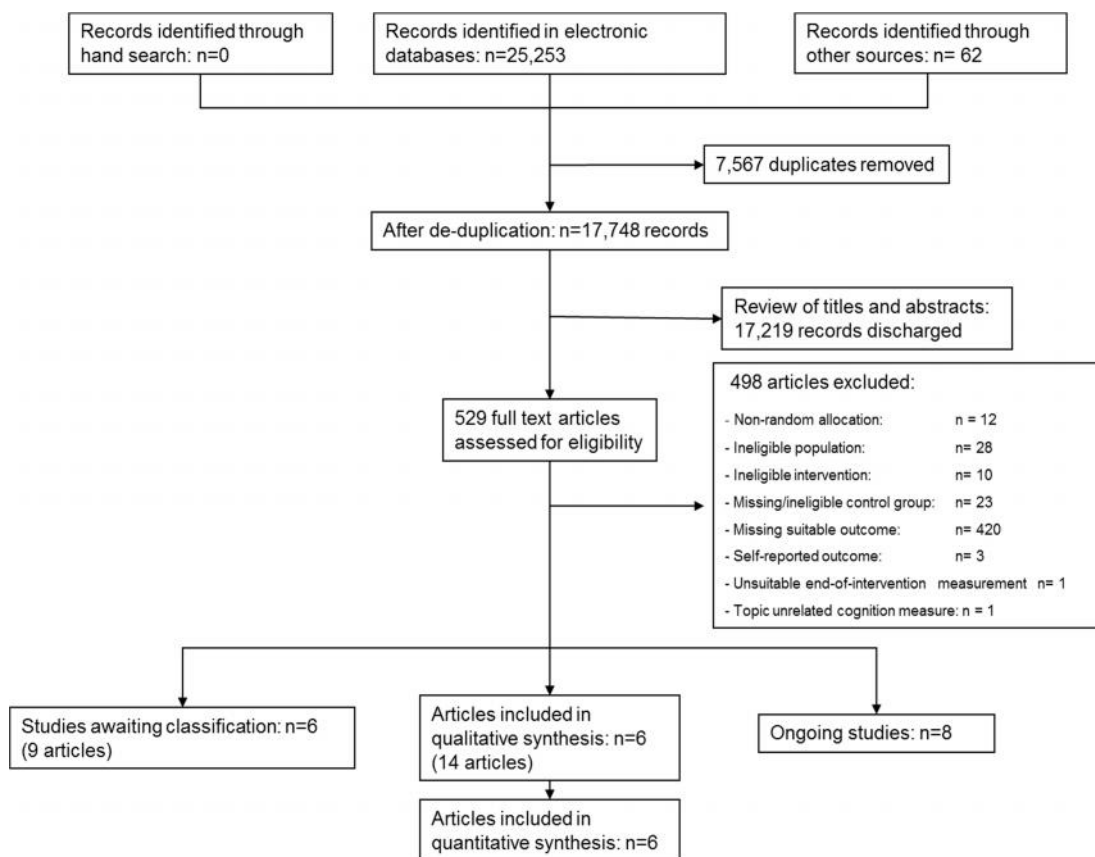
**Sensitivity analysis.** The influence of study characteristics on the robustness of the review results were investigated by conducting sensitivity analyses. Trials were removed from the analysis when studies:

- used different criteria or variations in the thresholds of criteria to define childhood overweight and obesity;
- were judged at ‘high risk’ of bias in the characteristics of random sequence allocation, concealment of allocation, blinding, and extent of dropouts;
- were cluster RCTs or cross-over trials;
- required imputation of missing data.

## **3.4. Main results**

### **3.4.1. Results of the search**

The literature search yielded 25,253 records of which 7,567 were duplicates. Sixty-two additional records were found primarily through screening the reference lists of relevant systematic reviews. Most of these additional records targeted the general population, rather than the overweight/obesity population only, or were non-randomised controlled trials, and, therefore, were not captured by the search strategy. We screened 17,748 titles and abstracts and we excluded 17,219 records. Since the primary or secondary outcomes of this review should not determine whether records are excluded based on title and abstract, we retrieved 529 full text articles of which six studies (total sample size = 674) met the inclusion criteria (for detailed description see Appendix 8.2.3). An additional six studies are awaiting classification, and eight studies are ongoing. The flow chart of the search results is shown in Figure 3.1.



**Figure 3.1: Study selection flow diagram**

### Included studies

**Study design, geographic location and setting.** We included two randomised controlled trials (Davis et al., 2011; Staiano et al., 2012) and four cluster randomised controlled trials (Ahamed et al., 2007; Johnston et al., 2013; Winter & Sass, 2011; Wirt et al., 2013). Of the six studies, four were conducted in the USA; one was carried out in Canada and one in Germany. Three studies took place in the classroom and/or within the school environment (Ahamed et al., 2007; Johnston et al., 2013; Staiano et al., 2012); one study provided an after-school intervention outside the school setting (Davis et al., 2011), and two studies delivered the intervention combined in the classroom and in participants' homes (Winter & Sass, 2011; Wirt et al., 2013).

**Population and sample size.** Half of the included studies did not publish data of overweight and/or obese children separately from the general population; therefore we contacted the authors to obtain the data. One study was carried out in pre-school children aged 3-5 years (Winter & Sass, 2011), four studies conducted the intervention in primary school children aged 6-13 years (Ahamed et al., 2007; Davis et al., 2011; Johnston et al., 2013; Wirt et al., 2013), and another study included adolescents aged 15-18 years (Staiano et al., 2012). The number of participants randomised ranged from 37 to 321 (total N = 792).

The overall proportion of girls was 57% and 53% in Staiano et al. (2012) and Wirt et al. (2013), respectively. The proportion of girls in the intervention group was 54% (Davis et al., 2011), 48% (Ahamed et al., 2007), 38% (Johnston et al., 2013), and 25% (Winter & Sass, 2011) whereas the proportion of girls in the control was 62% (Davis et al., 2011), 19% (Ahamed et al., 2007), 46% (Johnston et al., 2013), and 37% (Winter & Sass, 2011). The ethnic majorities in the study populations were Black (Davis et al., 2011; Staiano et al., 2012), Hispanic (Johnston et al., 2013; Winter & Sass, 2011), Asian (Ahamed et al., 2007), and South-East European (Wirt et al., 2013).

Attrition rates were 5.2% (Davis et al., 2011), 21.0% (Johnston et al., 2013), 24.3% (Wirt et al., 2013), 27.0% (Staiano et al., 2012), 27.5% (Winter & Sass, 2011), and 29.1% (Ahamed et al., 2007).

**Interventions and comparison.** Four of the included studies involved multicomponent lifestyle interventions (Ahamed et al., 2007; Johnston et al., 2013; Winter & Sass, 2011; Wirt et al., 2013); the remaining two studies involved single-component physical activity interventions. All interventions included engagement in physical activity; however, type, intensity, duration, and frequency varied between studies. Types of physical activity ranged from aerobic physical activity group sessions (Ahamed et al., 2007; Davis et al., 2011; Wirt et al., 2013) and general encouragement to increase physical activity throughout the day (Johnston et al., 2013; Winter & Sass, 2011) to playing an active video game ('exergaming') (Staiano et al., 2012). Multi-component interventions included, in addition to the physical



activity component, a behavioural change intervention in form of healthy lifestyle or nutrition education (Ahamed et al., 2007; Johnston et al., 2013; Winter & Sass, 2011; Wirt et al., 2013) and dietary intervention (Ahamed et al., 2007; Johnston et al., 2013). Interventions lasted 10 -13 weeks (Davis et al., 2011; Staiano et al., 2012), 6 months (Winter & Sass, 2011), one school year (Ahamed et al., 2007; Wirt et al., 2013), and two school years (Johnston et al., 2013). The comparison condition for all included studies was 'standard care' referring to usual physical activity and/or usual school curriculum, including physical education lessons. One study applied a waiting list control condition (Wirt et al., 2013).

**Outcomes.** In all studies, outcomes were measured at baseline and immediately after the intervention period finished. None of the studies performed further follow-up assessments.

#### a) School achievement

School achievement was assessed for mathematics (Ahamed et al., 2007; Davis et al., 2011; Johnston et al., 2013), vocabulary skills (Winter & Sass, 2011), reading (Ahamed et al., 2007; Davis et al., 2011; Johnston et al., 2013), English/language arts (Ahamed et al., 2007), and Science (Johnston et al., 2013) using the Woodcock-Johnson-Test of Achievement III (Davis et al., 2011), the Canadian Achievement Test (CAT-3) (Ahamed et al., 2007), the Peabody Picture Vocabulary Test III (Winter & Sass, 2011), and local attainment assessment criteria (Johnston et al., 2013). Of the four studies that assessed school attainment, two provided overall scores/ Grade Point Average (GPA) (Ahamed et al., 2007; Johnston et al., 2013). The remaining studies reported subject specific scores. Although receptive vocabulary skills measured by the Peabody Picture Vocabulary Test are often used as a measure of general intelligence, we classified it as a school attainment outcome because the trial authors intended to assess school readiness.

#### b) Cognitive function

Four out of the six included studies assessed cognitive function. The majority of studies measured specific cognitive domains rather than general intelligence. Two studies assessed executive function using the Das-Naglieri-Cognitive Assessment System (CAS) (Davis et al., 2011) and the Delis-Kaplan Executive Function System (Staiano et al., 2012); and two further studies assessed attention using the Das-Naglieri-CAS (Davis et al., 2011) and the KiTAP (Wirt et al., 2013). Other cognitive domains assessed included inhibitory control (KiTAP; (Wirt et al., 2013)), and successive and simultaneous processing (Das-Naglieri-CAS; (Davis et al., 2011)).

#### c) Future success

None of the included studies assessed measures of future success.

### **Excluded studies**

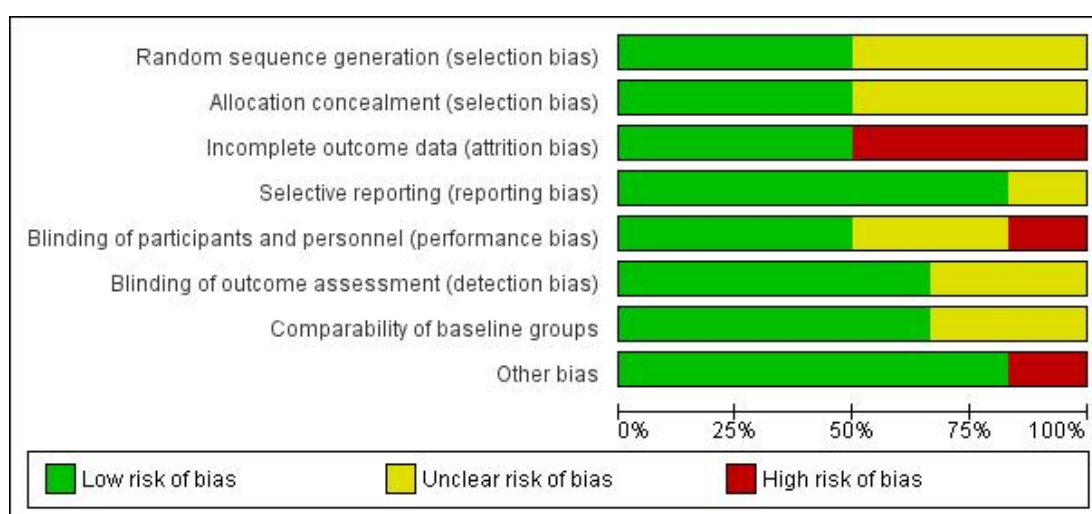
In total, 498 full text articles were excluded. For 420 articles the primary or secondary outcomes of interest were not reported in the article. Further reasons for exclusion were a non-randomised study design (12 articles), ineligible population (28 articles), ineligible intervention (10 articles), and missing/ineligible control condition (23 articles). Articles were excluded when the age of the population did not fall into the age range of 3-18 years or when studies did not focus on overweight or obese children. Ineligible interventions were considered to be those that did not aim to prevent or treat childhood overweight or obesity, for example, a behaviour change intervention to reduce teasing or health-risk behaviours such as aggression. Lifestyle interventions that were too short in duration (for example: a one-off session of 20 minutes physical activity) were not suitable for weight management, and thus not eligible for inclusion. Three articles were excluded because of self-reported outcomes, one article reported cognitive function scores related to appetite control rather than school achievement, and one study provided an inadequate end-of-intervention outcome measure.

Since the number of excluded full-text screened studies was too high to list, below are those lifestyle intervention studies that did not meet all inclusion criteria but:

- a) intended to prevent or treat childhood overweight or obesity and reported measures of school achievement or cognitive function (Delgado-Rico et al., 2012a; Gunnarsdottir et al., 2012b; Hollar et al., 2010; Hutson, 2008; Leidy, 2013; Milosis & Papaioannou, 2007; Reed et al., 2012; Robinson et al., 2010; Vanhelst et al., 2012; Verbeken et al., 2013b; Vos et al., 2011).
- b) reported measures of school achievement or cognitive function with a specific focus on overweight/obese children and adolescents without the primary intention to prevent or reduce obesity (Bartholomew & Jowers, 2011; Grieco et al., 2009; Hill et al., 2011; Tomporowski et al., 2008).

### 3.4.2. Risk of bias in included studies

The 'Risk of Bias tables' describe the reasons for the judgements of risk of bias for each bias item by included studies (Appendix 8.2.4.). Figure 3.2 illustrates the judgement for each risk of bias item across all included studies.



**Figure 3.2: Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included**

#### Allocation (selection bias)

*Random sequence generation.* Three studies were judged to be at unclear risk of bias (Ahamed et al., 2007; Staiano et al., 2012; Winter & Sass, 2011) and three studies

were judged to be at low risk of bias for random sequence generation (Davis et al., 2011; Johnston et al., 2013; Wirt et al., 2013).

The difference in gender proportion across experimental groups in Ahamed et al. (2007) may indicate a high risk of bias for randomisation. However, the difference in the proportion of overweight girls across groups can be explained by a cluster effect and the lack of stratified randomisation by gender. Data used for this review are only from a subgroup of the total study population, i.e. overweight and obese children. The gender distribution between intervention and control schools for the entire study population is fairly equal (intervention group: 50.7% girls, control group: 47.4% girls). It is unclear why the proportion of overweight girls is substantially lower in the control group than in the intervention group; it could have occurred by chance. Nevertheless, comparability of baseline groups might be at risk of bias (see 'Other potential sources of bias').

*Allocation concealment.* Of the six included studies, the risk of bias for allocation concealment was judged as unclear for three studies (Johnston et al., 2013; Staiano et al., 2012; Winter & Sass, 2011) and low for three studies (Ahamed et al., 2007; Davis et al., 2011; Wirt et al., 2013).

### **Blinding (performance bias and detection bias)**

*Participants and personnel.* True blinding of participants and personnel involved in delivering the intervention is not possible in a lifestyle intervention study. However, three studies (Ahamed et al., 2007; Davis et al., 2011; Staiano et al., 2012) blinded participants and personnel to the true purpose of the study and, therefore, were judged to be at low of risk for performance bias. Two studies were judged to be at unclear risk of performance bias (Johnston et al., 2013; Winter & Sass, 2011). Wirt et al., 2013 was judged to be at high risk for performance bias because the personnel (teachers) were not blinded; although the participants were blinded to the true purpose of the study.

*Outcome assessment.* The risk of bias for blinding of outcome assessment was judged to be unclear for two studies (Johnston et al., 2013; Winter & Sass, 2011) and low for four studies (Ahamed et al., 2007; Davis et al., 2011; Staiano et al., 2012; Wirt et al., 2013).

### **Incomplete outcome data (attrition bias)**

Of the six included studies, the risk of attrition bias was judged to be low in three studies (Davis et al., 2011; Johnston et al., 2013; Winter & Sass, 2011), but high in three studies (Ahamed et al., 2007; Staiano et al., 2012; Wirt et al., 2013) where no imputation of missing data was performed. The authors provided reasons for attrition (see Appendix 8.2.3). The attrition rates for studies judged to be at high risk were;

- in Ahamed et al. (2007) 29.1% with 16.6% higher attrition in the intervention group than control group (intervention arm: 26 out of 78 children, control arm: 4 out of 25 children),
- in Staiano et al. (2012) (Staiano et al., 2012) 27% with 16.3% and 13.8% higher attrition in the two intervention arms than control group (competitive intervention condition: 9 out of 19 children, cooperative intervention condition: 8 out of 19 children, control arm: 3 out of 19 children), and
- in Wirt et al. (2013) 24.3% (10 out of 37 children;). No group-specific data on different attrition rates at the child-level were available. Instead, cluster-level data refer to the whole study population rather than to overweight and obese children only.

Reasons for higher attrition in intervention groups compared to the control group in Staiano et al. (2012) could be intervention-related such as the reported reason that self-consciousness due to obesity was increased by taking part in the intervention or lack of interest. Other reported reasons, such as school transfer or pregnancy, are less likely to be attributable to taking part in the intervention. Similar intervention-related effects might be the reason for higher attrition in the intervention group in Ahamed et al. (2007). However, as this study is a cluster RCT reasons for higher attrition in intervention schools than control schools might be associated with the schools themselves rather than the intervention. Ahamed et al. (2007) reported that

proportionally more children from intervention schools moved or were absent on the day of testing than children from control schools. Wirt et al. (2013) reported that drop out occurred only at school or class level and that the attrition was double for classes in the control group (two classes) compared to the intervention group (one class). The reasons for missing data are described in Appendix 8.2.3.

### **Selective reporting (reporting bias)**

The risk for selective reporting was judged to be low in five studies (Ahamed et al., 2007; Davis et al., 2011; Staiano et al., 2012; Winter & Sass, 2011; Wirt et al., 2013) and unclear in the remaining study by Johnston et al. (2013).

### **Other potential sources of bias**

Two additional potential biases were detected;

- Comparability of baseline groups might be a potential source of bias in cluster RCTs (four studies). Two cluster RCTs were free of this source of bias (Johnston et al., 2013; Winter & Sass, 2011). Two studies were judged to be at unclear risk of bias (Ahamed et al., 2007; Wirt et al., 2013).
- Body weight alone is an unreliable measure of obesity and hence is at risk of measurement bias. One study was judged to be at high risk of measurement bias for measurement of obesity (Staiano et al., 2012). The remaining studies were free of this potential source of bias because obesity status was assessed using established age- and gender-specific BMI cut-offs.

## **3.4.3. Effects of interventions**

### **3.4.3.1. Primary outcomes**

The limited number of included studies restricts the usefulness of meta-analyses therefore we present the findings on school attainment for each study separately. Where possible we determined the statistical heterogeneity of studies with similar methodology. We corrected the number of participants for cluster randomisation for studies that did not take cluster-randomisation into account (Ahamed et al., 2007; Winter & Sass, 2011) by calculating the effective sample size (see Unit of analysis

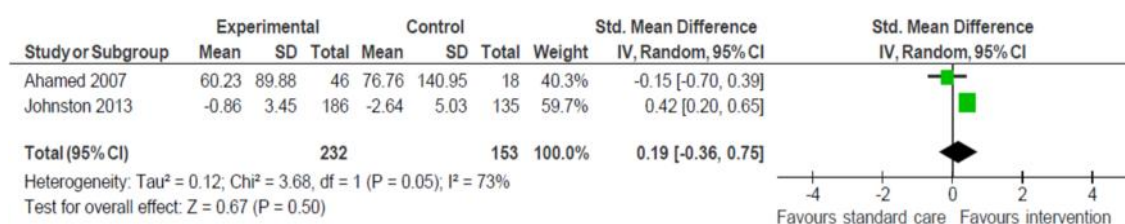
issues). No subgroup analysis was performed due to the low number of included studies.

### **Overall school attainment**

Two studies provided pre/post-intervention change data on the effect of school-based multicomponent lifestyle interventions on overall attainment in the subjects mathematics, reading, language (Ahamed et al. (2007) only), and science (Johnston et al. (2013) only) in overweight and obese children.

Johnston et al. (2013) tested the effect of healthy lifestyle education and nutrition interventions on Grade Point Average scores in 253 overweight and obese children aged 7 to 9 years. Findings indicate a MD of 1.78 points (95% CI 0.8 to 2.76,  $P < 0.001$ ) on a scale from 0 to 100 favouring the intervention group. Ahamed et al. (2007) described the findings of 'Action Schools! BC', an intervention focusing on increased physical activity and fruit and vegetable intake for children aged 7 to 11 years. Intervention effects on average school attainment measured using the Canadian Achievement Test 3 in 64 overweight and obese children suggested a non-significantly beneficial effect in the control group (MD = -16.53, 95% CI -86.63 to 53.57,  $P = 0.64$ , scale mean score = 500, scale SD = 70).

The two studies were combined in a meta-analysis. Although similar in terms of age group, intervention mode and outcome, there was a high level of statistical heterogeneity ( $I^2$ ). This could be explained due to differences in intervention dose. The intervention duration in Johnston et al (2013) was two years which is double the dose of the study by Ahamed et al. (2007). Risk of bias assessment suggests a high risk of attrition bias in Ahamed et al. (2007) whereas for Johnston et al. (2013) information for most risk of bias items were not obtainable and therefore assessed as 'unclear'. Since different assessment scales were used the standardised mean difference (SMD) of change scores in school attainment between intervention and control group was calculated (SMD = 0.19 units; 95% CI -0.36 to 0.75,  $P = 0.5$ ,  $I^2 = 73\%$ ). Therefore, combined results suggest no significant benefit of multicomponent lifestyle interventions on overall school attainment in overweight and obese primary school aged children (Figure 3.3).



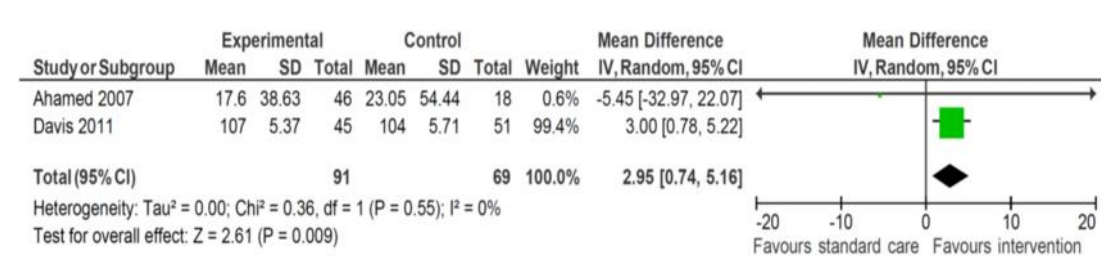
**Figure 3.3: Forrest plot of the effect of lifestyle interventions versus standard care on overall school attainment**

### Mathematics attainment

The effect of lifestyle interventions on mathematics attainment was assessed in two studies. One study was a single-component study employing an after-school aerobic physical activity intervention (Davis et al., 2011) and one study was a multicomponent intervention (Ahamed et al., 2007). The studies differed in the test tool used to assess mathematics attainment; Davis et al. (2011) applied the Woodcock-Johnson Test of Achievement III whereas Ahamed et al. (2007) used the Canadian Achievement Test 3.

Individual study data from Davis et al. (2011) indicate that 40 minutes vigorous-intensity physical activity for five days per week over a period of 13 weeks significantly improved mathematics attainment in overweight and obese children aged 7 to 11 years ( $N=96$ ). The MD of mathematics scores was 3.00 points (95% CI 0.78 to 5.22,  $P = 0.008$ ) relative to the standardised test score with a mean of 100 and SD of 15. There was no evidence of an intervention effect in Ahamed et al.'s (2007) multicomponent lifestyle intervention. The MD of changes in mathematics scores between the experimental groups of 64 overweight children aged 9 to 11 years was 5.45 points (95% CI -32.97 to 22.07,  $P = 0.7$ ) relative to standardised mean scores of 500 (SD 70). Given the large weight of Davis et al.'s (2011) study, pooled study data yielded a MD in achievement scores of 2.95 units (95% CI 0.74 to 5.16,  $P < 0.01$ , Figure 3.4) with no indication of statistical heterogeneity ( $I^2 = 0\%$ ).





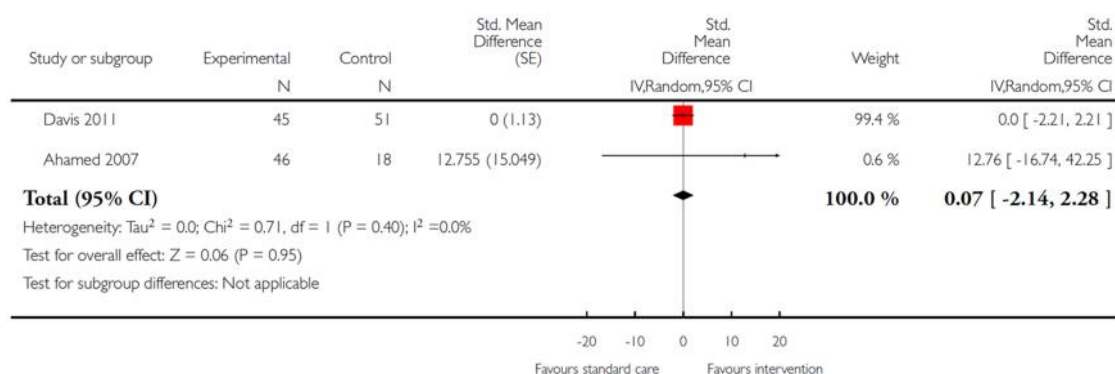
**Figure 3.4: Forrest plot of the effect of lifestyle interventions versus standard care on mathematics attainment**

### Language attainment

Language attainment included both reading and writing skills of children and adolescents and was assessed by Ahamed et al. (2007). Results from this single study indicated no significant effect of a school-based multicomponent lifestyle intervention aiming to increase physical activity and fruit and vegetable intake on language achievement in 64 overweight or obese children (age range 9 to 11 years). The MD of language attainment scores between intervention and control group was 27.97 points (95 % CI -5.35 to 61.29, P = 0.10; scale mean = 500, SD = 70).

### Reading attainment

Similar to mathematics attainment, reading attainment was assessed by the two studies which differed in type of intervention (after-school physical activity versus school-based physical activity and dietary changes) and intervention duration (13 weeks versus one school year) as well as in the tool used to assess reading attainment (Woodcock-Johnson Test of Achievement versus Canadian Achievement Test). Individual study data of both studies suggested no significantly beneficial effect of the interventions on reading attainment (Ahamed et al., 2007; Davis et al., 2011). The MD was 0.00 (95% CI -2.22 to 2.22, P = 1.00) relative to the standardised test score with a mean of 100 and SD of 15 in Davis et al. (2011) and 12.76 units (95% CI -16.74 to 42.25, P = 0.40; scale mean = 500, SD = 70) in Ahamed et al. (2007). No statistical heterogeneity was detected after combining both studies (SMD = 0.07 units, 95% CI -2.14 to 2.28, P = 0.95, I<sup>2</sup> = 0%, Figure 3.5).



**Figure 3.5: Forrest plot of the effect of lifestyle interventions versus standard care on reading attainment**

### Writing attainment

None of the included studies provided data on the effect of lifestyle intervention on writing attainment in overweight or obese children and adolescents.

### Vocabulary attainment

Vocabulary attainment was assessed by one study: Winter et al. (2011) using the Peabody Picture Vocabulary Test III. There was no significant evidence of the effect of lifestyle education combined with encouragement to increase physical activity on vocabulary skills in overweight and obese pre-school children (aged 3 to 5 years) regardless of whether missing data were imputed or not. The proportion of missing data which required imputation was 27.5% of the total sample. This proportion is considered to be high (Fewtrell et al., 2008). Therefore we reported the results for the study population with post-intervention measures separately from result after imputation of missing post-intervention data. The MD for imputed data was 1.19 units (95% CI -4.04 to 6.42,  $P = 0.69$ ,  $N = 80$ ); the MD for 66 participants without missing data was 2.60 units (95% CI -3.04 to 8.24,  $P = 0.40$ ) relative to the standardised test score with a mean of 100 and SD of 15.

### **Special educational classes**

No study provided data on the effect of lifestyle interventions on the need for special educational classes or reduction of time allocated to special educational class.

### **3.4.3.2. Secondary outcomes**

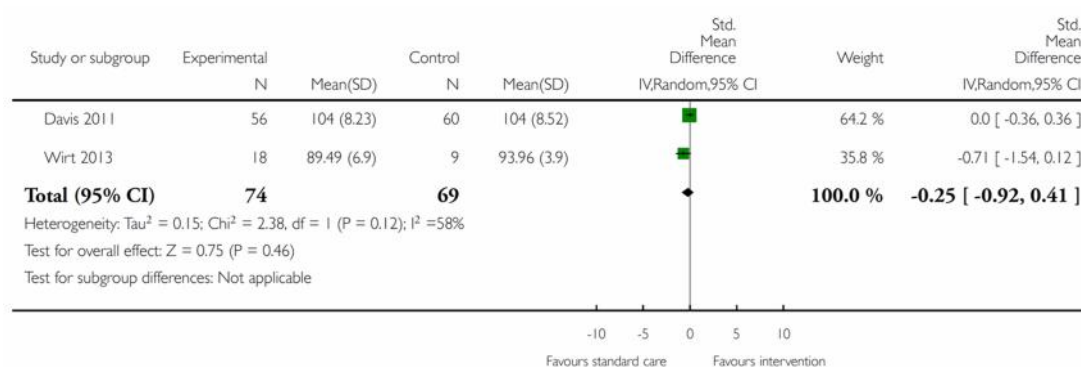
#### **Cognitive function**

Data for evaluating the effect of lifestyle intervention on cognitive function were available from three studies (Davis et al., 2011; Staiano et al., 2012; Wirt et al., 2013). As for the primary outcomes, findings for each study are described by type of outcome measure and where suitable results of meta-analyses for description of the heterogeneity between studies are presented. The low number of included studies prevented us from conducting meaningful subgroup analyses. All three studies delivered a physical activity intervention and one of the three studies included also healthy lifestyle education (Wirt et al., 2013). The number of participants for cluster randomisation was corrected for Wirt et al. (2013) calculating the effective sample size (see Unit of analysis issue).

*Attention.* Davis et al. (2011) and Wirt et al. (2013) assessed the effect of lifestyle interventions on attention abilities in overweight and obese children. There was no significant evidence of a beneficial effect of 40 minutes aerobic vigorous-activity physical activity on five days per week for in total 13 weeks on attention scores in 116 children aged 7 to 11 years measured by the Das-Naglieri Cognitive Assessment System. The MD was 0.00 units (95% CI -3.05 to 3.05,  $P = 1.00$ ) relative to the standardised test score with a mean of 100 and SD of 15 (Davis et al., 2011). In contrast, an intervention combining lifestyle education and physically activity lessons in school over one school year indicated a significant beneficial effect of attention scores in the pre-school aged control group ( $N = 27$ ) (Wirt et al., 2013). The MD was - 4.47 units (95% CI -8.55 to -0.39,  $P = 0.03$ , standardised scale mean = 50, SD 10). Wirt et al. (2013) used the KiTAP tool to assess attention abilities.

Meta-analysis indicated a moderate heterogeneity ( $I^2 = 56\%$ ) between the combined studies most likely explained by the different types of interventions (Figure 3.6). Combined results indicated no statistically significant evidence of the effect of

lifestyle interventions on attention ability in 143 overweight and obese children aged 6 to 11 years based on two studies (SMD = - 0.25 units, 95% CI -0.92 to 0.41, P = 0.46).

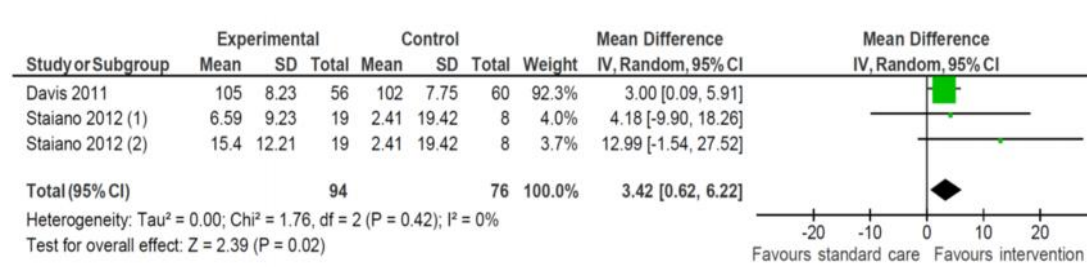


**Figure 3.6: Forrest plot of the effect of lifestyle interventions versus standard care on attention**

*Executive function.* Davis et al. (2011) and Staiano et al. (2012) reported findings on executive function in overweight and obese children and adolescents after participation in a physical activity intervention. Individual study data by Davis et al. (2011) suggested that an after-school vigorous-intensity physical activity intervention (40 minutes on five days per week over 13 weeks) improved executive function scores by three points (95%CI 0.09-5.91,  $P = 0.04$ , scale mean 100, SD 15,  $N = 96$ ) assessed using the Planning scale of the Das-Naglieri Cognitive Assessment System. On the contrary, a school-based exergaming intervention with a competitive or cooperative condition that took place on average once a week for 30-60 minutes was not beneficial for improvement of executive function of 52 children aged 15 to 18 years compared to usual school routine (Staiano et al., 2012). The MD for the cooperative exergaming condition was 4.18 (95% CI -9.90 to 18.26,  $P = 0.56$ ) and the MD for the competitive condition was 12.99 (95% CI -1.54 to 27.52,  $P = 0.08$ ). Executive function was assessed using the Design Fluency and Trail-Making sub-scales of the Delis-Kaplan Executive Function System (scale mean = 10, SD = 3).

Despite the difference in children's age between studies, both studies are similar in methodology and outcome, hence we performed a meta-analyses which suggested that physical activity interventions can improve executive function in 170

overweight or obese children and adolescents aged 7 to 18 years. The MD was 3.42 units (95% CI 0.62 to 6.22,  $P = 0.02$ ,  $I^2=0\%$ ) (Figure 3.7). One study reported post-intervention scores (Davis et al., 2011) and the other study reported change scores (Staiano et al., 2012). Therefore we used the mean difference rather than the standardised mean difference to evaluate the effect of physical activity on executive function in overweight and obese children (Higgins & Green, 2011).



#### Footnotes

(1) cooperative exergaming condition versus control

(2) competitive exergaming condition versus control

**Figure 3.7: Forrest plot of the effect of lifestyle intervention versus standard care on executive function**

*Inhibitory control.* One study assessed the effect of a school-based lifestyle education including physically activity lessons for a period of one year on inhibitory control in overweight or obese children (Wirt et al., 2013). There was no significant evidence of an intervention effect on inhibitory control in 18 overweight or obese pre-school children (6 to 8 years). The MD was 0.26 units (95% CI -1.27 to 1.79,  $P = 0.74$ , standardised scale mean = 50, SD 10).

*Working memory.* Working memory was assessed through the successive processing scale of the Das-Naglieri Cognitive Assessment System. Results indicated that 40 minutes vigorous-intensity physical activity on 5 days per week over in total 13 weeks significantly improved working memory in overweight and obese children ( $N = 116$ ) aged 7 to 11 years (Davis et al., 2011). The MD of working memory scores between intervention and control group was 3.00 units (95% CI 0.51 to 5.49,  $P = 0.02$ ) relative to the standardised test score with a mean of 100 and SD of 15.

*Simultaneous processing.* The simultaneous processing scale of the Das-Naglieri Cognitive Assessment System tests verbal and non-verbal spatial relations and memory. There was no significant evidence of an effect of Davis et al.'s (2011) after-school physical activity intervention on simultaneous processing ability in 116 overweight or obese children aged 7 to 11 years. The MD was 1.00 unit (95% CI - 2.19 to 4.19,  $P = 0.54$ ) relative to the standardised test score with a mean of 100 and SD of 15.

### **Future success**

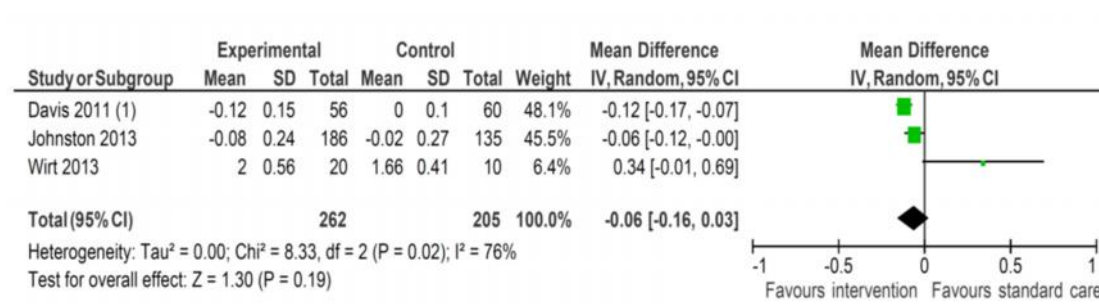
No study provided data on the effect of lifestyle interventions on future success such as years of schooling, earning or college enrolment in overweight or obese children and adolescents.

### **Obesity indices**

The effect of lifestyle interventions on body weight status was only assessed for included studies that indicated a significant effect (positive or negative) on at least one of the above outcome measures. Four out of six included studies indicated a significant change in measures of school attainment and/or cognitive function (Davis et al., 2011; Johnston et al., 2013; Staiano et al., 2012; Wirt et al., 2013). Staiano et al. (2012) however, reported only intervention effect on body weight which is not considered as a reliable tool to determine overweight and obesity. Therefore only the results of Davis et al. (2011), Johnston et al. (2013), and Wirt et al. (2013) are presented.

Johnston et al. (2013) and Davis et al. (2011) provided change scores while Wirt et al. (2013) provided post-intervention BMI z-scores. Johnston et al. (2013) and Davis et al. (2011) findings suggested a small but statistically significant beneficial effect of the intervention on the BMI z-score. The MD was -0.06 BMI z-scores (95% CI - 0.12 - 0.00,  $P = 0.04$ ) and -0.12 BMI z-scores (95% CI -0.17 to -0.07,  $P < 0.001$ ), respectively. However, there was no evidence of a beneficial intervention effect on body weight status in the study by Wirt et al. (2013). The MD was 0.34 standard deviations (95% CI -0.01 to 0.69,  $P = 0.06$ ,  $N = 30$ ) (Wirt et al., 2013).

Combined effects of all three studies suggested a non-significant beneficial effect of lifestyle interventions on children's BMI z-scores. The MD was -0.06 (95% CI -0.16 to 0.03,  $P = 0.19$ , Figure 3.8). However, the meta-analysis indicated a substantial heterogeneity between studies ( $I^2 = 76\%$ ) which can be explained by the substantial methodological differences of the interventions (type, setting, duration).



#### Footnotes

(1) BMI z-scores were unpublished and obtained through personal communications.

**Figure 3.8: Forrest plot of the effect of lifestyle intervention versus standard care on BMI z-scores**

### 3.4.4. Sensitivity analysis

The low number of included studies limits the applicability of subgroup analysis and sensitivity analysis. Nevertheless, sensitivity analyses were performed to consider the impact of cluster RCTs and/or 'high risk' attrition bias on the intervention effect. Sensitivity analyses show that the results on reading attainment, executive function and attention and the overall conclusion were not affected by the inclusion of cluster RCTs and studies with high attrition. However, the results of the effect of lifestyle interventions on overall school attainment and mathematics attainment changed significantly statistically when the cluster RCT which was also at 'high risk' for attrition bias was excluded. Sensitivity analyses suggested a beneficial effect of a school-based healthy lifestyle education and nutrition intervention and an aerobic physical activity intervention on overall school attainment and mathematics attainment in overweight and obese primary school children, respectively.

## 3.5. Discussion

### 3.5.1. Summary of main results

**School achievement.** Of the six included studies, four assessed the effect of lifestyle interventions on school attainment in overweight and obese children. Studies used different concepts of school attainment, i.e. overall school attainment or specific school subjects, which meant that only one or two studies could be included per outcome measure for analysis. There was no evidence of a beneficial effect of multicomponent lifestyle interventions on changes in overall school attainment in overweight and obese children aged 7 to 11 years (Ahamed et al., 2007; Johnston et al., 2013). However, considering both available studies separately, the study with a lower risk of bias and longer intervention duration suggested a small but significant benefit of a multicomponent intervention (MD = 1.78 points, 95% CI 0.8 to 2.76,  $P < 0.001$ , scale range: 0 to 100). Similarly beneficial effects were detected for mathematics attainment. Combined results of available studies did not indicate improvement of mathematics attainment in the intervention group most likely attributable to the large heterogeneity of the studies in terms of type of intervention and duration. However, after sensitivity analysis, individual study findings of the physical activity only intervention yielded in increased mathematics scores in overweight and obese children by three points (95% CI 0.78 to 5.22,  $P = 0.008$ , scale mean 100, SD 15) (Davis et al., 2011). No statistically significant evidence was suggested for improvement of reading attainment, language attainment and vocabulary skills.

**Cognitive function.** Three studies investigated the effect of lifestyle interventions on five different specific cognitive abilities; executive function, inhibitory control, attention, working memory, and simultaneous processing. The results indicated a significant improvement of executive function and working memory in overweight and obese children and adolescents (Davis et al., 2011; Staiano et al., 2012). The MD for executive function was 3.42 (95% CI 0.62 to 6.22,  $P = 0.02$ ) and for working memory 3.00 (95% CI 0.51 to 5.49,  $P = 0.02$ ). There was no significant evidence of a beneficial effect of lifestyle interventions on inhibition control (Wirt et al., 2013),



attention (Davis et al., 2011; Wirt et al., 2013) and simultaneous processing (Davis et al., 2011) in overweight and obese children.

***Future Success.*** No data currently exist which examine whether lifestyle interventions for overweight or obese children and adolescents influence indices of future success after schooling has been completed.

***Obesity indices.*** We analysed the effect of lifestyle interventions on obesity indices in studies that indicated a statistically significant effect of lifestyle interventions on school attainment or cognitive function. This enabled us to assess whether or not any changes in the outcome variables occur independently of changes in obesity in three studies. Two studies suggested a small but significant beneficial effect on both average attainment and BMI z-scores (Davis et al., 2011; Johnston et al., 2013); these were larger trials of low risk of bias. Another study which indicated a significant improvement in the control group also reported, although only approaching the 5% significance level, a lower BMI standard scores in the control (Wirt et al., 2013).

### **3.5.2. Overall completeness and applicability of evidence**

There are very few studies investigating the effect of lifestyle interventions on school attainment or cognition in overweight and obese children and adolescents. Those studies that exist have a range of methodological issues. During the literature review we faced several challenges relating to the nature of the intervention, study population, and outcome. A lifestyle intervention is a broad and complex construct. We followed the definition used by clinical guidelines for the prevention and treatment of childhood obesity and developed the search strategy on this basis. Studies that applied childhood obesity related lifestyle interventions that fall outside the definition used might have been missed. Moreover, our literature search focused on lifestyle intervention studies that intended to prevent or reduce childhood obesity. Studies that employed a lifestyle intervention that is part of paediatric weight management but not aiming to prevent or reduce obesity were likely not to be included in this review. Our population group of interest, overweight and obese children and adolescents, is a very specific - yet substantial and increasing -

subgroup of the general population. Many studies did not report results of the overweight or obese subgroup separately from normal weight children. For some studies, the data were not obtainable to date. Finally, lifestyle intervention studies in this population do not tend to assess and/or report school attainment, cognitive function or future success as primary outcome or secondary outcome.

All included studies were conducted in high-income countries. Although some studies targeted low-income children (Staiano et al., 2012; Winter & Sass, 2011) evidence might not be applicable to low- and middle-income countries. Available evidence for school attainment included children of primary school age (6 to 11 years) only. Therefore, the effect of lifestyle interventions on school attainment in pre-school children and adolescents in secondary/high school need to be determined in future studies. In contrast, evidence for cognitive function included a broad age range; from primary school aged children to high school students aged up to 18 years. No study reported the effect of lifestyle interventions on future success.

The majority of studies investigated the effect of multicomponent lifestyle intervention on school attainment and cognitive function comprising a nutrition component (for example: modification of school meals towards nutrient-dense food), a physical activity component and a healthy lifestyle education component. Two studies delivered a single-component physical activity intervention. Evidence is lacking on the effect of behaviour change interventions using established behaviour change techniques for the treatment of childhood obesity such as stimulus control and self-monitoring (NICE, 2013; SIGN, 2010). None of the included studies employed a single-component intervention on healthy diet or reduced intake of sugar-sweetened beverages. Additionally, none of the included studies attempted to determine specifically the effect of reduced sedentary behaviour on school attainment and cognitive function. However, the healthy lifestyle education component by Wirt et al. (2013) included lessons on reducing media screen time and Ahamed et al. (2007) and Johnston et al. (2013) delivered physically active classroom lessons. Both lifestyle education on reducing media screen time and

physically active lessons might be considered as interventions to decrease sedentary behaviour (time spent sitting). The body of available evidence does not allow us to explore whether a specific component of a lifestyle intervention is more effective than another or whether the multicomponent intervention proves to be the better approach for improving school attainment and cognitive function in overweight and obese children and adolescents. Since all studies performed post-intervention measures immediately after intervention without further follow-up, no evidence on retention of the effect is available.

Overall, the total number of overweight and obese children included in this review is low ( $N = 674$ ). This limits the generalisability of the results. Moreover, the majority of included studies targeted the general population (normal weight and overweight or obese children) which might influence the intervention effect on school attainment and cognition in the overweight and obese paediatric population. Only two studies restricted participants to overweight or obese children and adolescents (Davis et al., 2011; Staiano et al., 2012). Those two studies indicated promising effects of physical activity interventions on school and cognitive outcomes but methodological issues may limit applicability of findings for clinical and public health practice.

Only three studies allowed an exploration of whether changes in academic and cognitive abilities were connected to changes in indices of obesity. Emerging evidence suggests a link between improvement of academic or cognitive skills and reduction of BMI z-scores.

### **3.5.3. Quality of the evidence**

GRADEpro software developed by the Grading of Recommendations Assessment, Development and Evaluation (GRADE) Working Group (Brozek et al., 2008) was used to assess and grade the quality of evidence of primary outcomes. A sensitivity analysis was performed by generating two Summary of Findings tables, the first excluded studies with high risk of bias and the second included all studies (Martin et

al., 2014). There were limitations in study design and implementation for language attainment, and a high risk of attrition bias was detected. We considered this limitation to lower confidence in the estimate of effect and therefore we downgraded the evidence by one level. Risk of attrition bias was not considered as a factor affecting the quality of evidence for overall school attainment, mathematics attainment, and reading attainment because studies with higher weight were of low risk for attrition bias. Studies aiming at the general population, and not at overweight or obese children explicitly, suggested indirectness of outcomes. This was present for all primary outcomes. However, we downgraded the quality of evidence by one level only for overall school attainment, language attainment, and vocabulary attainment. Mathematics and reading attainment were not downgraded for indirectness because the study with the higher weight was not affected by indirectness. Moreover, the small sample size of two included studies might suggest imprecision of evidence (wide confidence intervals) for language and vocabulary attainment. Thus, we downgraded the quality for language and vocabulary attainment by one level. We downgraded the quality of evidence for overall school attainment, mathematics attainment, and reading attainment by one level due to inconsistency of findings most likely caused by differences between studies in intervention type and duration. Given the low number of included studies (less than 10 per meta-analysis), we did not assess publication bias using the funnel plot. Risk of bias assessment indicated a low risk of selective reporting for all studies/outcomes, which we regarded as unlikely to affect the quality of evidence negatively. In summary, the quality of evidence for overall school attainment was low, for mathematics and reading attainment moderate, for vocabulary attainment low, and for language attainment very low.

Throughout the review, there was a priority of reporting of the sensitivity analyses where risk of bias and differences in intervention type and duration were suspected to have influenced the findings substantially. After conducting sensitivity analyses, the quality of evidence increased for the outcomes overall attainment, mathematics attainment, and reading attainment. The quality of evidence for overall school attainment was assessed to be moderate; downgrading of the evidence occurred for indirectness since the intervention was aimed at the general population. The quality

of evidence for both mathematics and reading attainment was not downgraded, thus the quality was high.

#### **3.5.4. Potential biases in the review process**

Since there was the intention to review the evidence on the effect of an intervention which is difficult to define in a specific subgroup of the general population, the following limitations should be considered.

First, although it is likely that all relevant studies on the reviewed topic were identified, the high number of additional records not identified through our pre-defined literature search may indicate limitations of the search strategy. However, most of the additionally screened records (identified from reference lists of systematic reviews) were non-randomised lifestyle interventions and/or interventions without specific focus on overweight or obese children. Hence, those records were not intended to be identified by our search strategy because the studies deviated from the study design and population criteria. On the other hand, because of this relevant studies that included the general population might have been missed and separate outcomes for overweight or obese children and adolescents might be obtainable. Of the 62 additional records only one met the inclusion criteria. Additionally, relevant outcomes of at least one study (dissertation) might have been missed because it was not possible to find contact details of the author.

Second, given that only a very small number of studies per outcome (one or two studies) with mainly low sample sizes were available, the strength of the evidence on the effect of lifestyle interventions for improving school attainment and/or cognitive function in overweight and obese children and youth is limited. There was insufficient information on whether the studies were adequately powered. This was partly due to the fact that data of the overweight and obese sub-population were provided and studies were potentially powered for the total study sample. Therefore, both significantly beneficial effects of lifestyle interventions and evidence of no effect need to be considered cautiously.

Third, it should also be noted that the standard deviation of the change may not be equal to standard deviation of the mean at a given time point, even when they are on the same scale ( $M=100$   $SD=15$  for example). Ways to impute any missing

data so that all studies can provide similar information (changes, or post-intervention values with corresponding SDs) should be explored in future work.

Fourth, the absence of an effect might also be attributable to poor adherence to the experimental condition, particularly when the intervention was applied in participants' homes (for example: physical activity homework tasks). Assessment of participants' compliance to the lifestyle intervention was often poorly reported. A similar bias for the assessment of adherence to the control condition was observed. Most studies did not attempt to evaluate and/or report whether the control group maintained their standard care during the trial period. For example, changes in school policy concerning healthy lifestyle factors such as improved school meals or physical activity opportunities during recess could potentially bias the intervention effect of experimental trials. The same may account for engagement in lifestyle changes at the family or child level.

Fifth, most studies linking lifestyle interventions to school attainment and cognitive function in overweight and obese children and youth did not address co-morbidities when selecting the study population. There are several co-morbidities that are associated with childhood obesity and/or school and cognitive outcomes including asthma, hypertension, type II diabetes and attention-deficit-hyperactivity disorder (ADHD). For example, lifestyle interventions for prevention and treatment of obesity (i.e. nutrition, physical education, health education) also had a significantly beneficial effect on school attainment in children with asthma (Murray et al., 2007). The actual treatment effect of lifestyle interventions in overweight children with co-morbidities may be under- or overestimated. On the other hand, Davis et al. (2011) stated that inclusion of overweight children with ADHD did not change the findings on treatment effects (Davis et al., 2011).

Finally, studies used a wide range of school attainment and cognitive function test tools. Although there tend to be correlations between cognitive function tests, in particular (because of the general cognitive factor, *g*), different cognitive tests vary in their specificity for different cognitive domains. Moreover, successive testing before and after the intervention is likely to improve participant scores due to repeated measures and regression to the mean. Thus, an improvement may not be due to the

intervention, although the use of a control group allows some controlling for this. On the other hand, the small participant numbers limits the ability to minimise bias.

### **3.5.5. Agreements and disagreements with other studies or reviews**

There are no further studies than those reviewed and no other (systematic) literature reviews on this specific topic. However, systematic reviews on physical activity, diet and general school health interventions on school and cognitive achievement in the general population exist. Although these systematic reviews may include some overweight and obese children they lack a separately analysed overweight and obese paediatric subgroup, thus they are difficult to compare with this systematic review.

Findings from meta-analyses on physical activity interventions on school attainment and/or cognitive function in the general child and youth population are in agreement with the results of this systematic review which focused on the effect on overweight or obese children only; that is that physical activity interventions improved school and cognitive outcomes. Sibley et al. (2003) stated that the overall estimated effect size from 16 true-experimental studies was 0.24 units ( $SD = 0.24$ ,  $P < 0.05$ ) (Sibley & Etnier, 2003). A meta-analysis of 39 experimental and quasi-experimental studies by Fedewa et al. (2011) indicated an overall effect size of 0.35 units ( $SE = 0.04$ , 95% CI 0.27 to 0.43; random-effect model) (Fedewa & Ahn, 2011). The systematic review on the effect of breakfast consumption and healthy diets on educational attainment confirmed the findings of this review in the sense that there is a lack of high quality studies and therefore no convincing evidence (Ells et al., 2008). Similar results were obtained by Murray et al. (2007), who systematically reviewed the literature on effects of coordinated school health programmes, which included, for example, nutrition service, physical education and health education, on school attainment (Murray et al., 2007).

Besides the focus on the general child and youth population these systematic reviews differ from this review in their methodological quality. A thorough assessment of the quality and risk of bias of included RCTs was missing in most of the above studies

and a less rigorous literature search was performed by some of the systematic reviews (for example: search of selected electronic data bases only).

## **3.6. Conclusions**

### **3.6.1. Implications for practice**

Currently, there are too few data to influence practice. However, evidence on the effect of lifestyle interventions did indicate a significant, albeit small, improvement of overall school attainment, mathematics attainment, executive function, and working memory in overweight or obese children living in high-income countries. The magnitude of improvement could have practical significance considering, for example, a mean difference of three points represents one third of the change in score required to change from 'low average' to 'average' on a 0 to 200 scale of mathematics attainment using the Woodcock-Johnson Test of Achievement III. An overweight or obese child in the upper range of 'low-average' achievement might benefit from a lifestyle intervention moving into the 'average' achievement category. Therefore, lifestyle interventions implemented in the school-setting or as after-school programmes may benefit school achievement and associated specific cognitive abilities in overweight and obese children and adolescents, in addition to previous studies which have shown beneficial effects for children in general. Although these benefits are small, the high prevalence of obesity among children means the gains are still valuable.

The majority of included studies took place as part of the curriculum or were implemented in a comprehensive whole-school approach indicating similar interventions are feasible to introduce in school practice. Health policy makers should consider these potential additional benefits when promoting physical activity and healthy eating (i.e. body weight-related behaviours) in schools. Evidence on the effect of lifestyle interventions on school achievement and cognitive function in overweight and obese children conducted in clinical and community setting is missing and therefore no implication for clinical practice and community interventions can be drawn.



### **3.6.2. Implications for research**

Overall, there is a need for more well-designed randomised controlled lifestyle intervention trials in overweight and obese children aged 3 to 18 years assessing school achievement and/or cognitive function, in particular in low- and middle-income countries where the prevalence of childhood obesity is rising (WHO, 2014). Future childhood obesity treatment trials in both clinical and school settings should consider including school achievement and cognitive outcomes. Studies conducted in the general paediatric population should report school attainment related outcomes separately for the overweight subgroup. Evidence on the effect of dietary interventions, behaviour change techniques, and reduced sedentary behaviour is needed. Low cognitive abilities could be associated with behaviours that cause obesity (reverse causation); therefore identifying which components of lifestyle interventions benefit specific cognitive domains could optimise both the physical and cognitive outcomes of obesity treatment programmes. Longer-term follow-up trials are needed to determine whether improvement in school achievement and cognitive function are sustainable over time and thus affect future success. Since engagement in lifestyle interventions, and school achievement and cognitive function varies between gender and ethnicity (Demack & Drew, 2000), it is important that future trials consider these factors. High rates of loss to follow-up assessment are a common problem in lifestyle intervention particularly involving overweight and obese children and adolescents. To reduce the risk of attrition bias researchers should consider methods to impute missing outcome data in their analysis and report characteristics of, and reasons for, missing data. In addition, availability of larger studies might allow investigation of whether there is a dose-response relationship between lifestyle interventions and improvement of school achievement and cognitive function in overweight children and adolescents.

**Summary: Lifestyle interventions for improving school achievement in overweight and obese children and adolescents**

***Findings:***

- Despite the large number of childhood obesity treatment trials, there is a surprising lack of evidence on their impact on school achievement and cognitive abilities.
- Multicomponent interventions targeting physical activity and healthy diet could benefit general school attainment in overweight/obese children.
- Physical activity interventions could benefit mathematics achievement, executive function, and working memory in overweight/obese children.

***Implications of practice and research:***

- Health policy makers should consider these potential additional benefits when promoting physical activity and healthy eating in schools.
- Future obesity treatment trials should consider academic and cognitive as well as physical outcomes.

## **CHAPTER 4: Effectiveness of childhood weight management on participant's educational attainment**

### **Aims and objective:**

- To establish the feasibility of a definitive study examining the effectiveness of lifestyle interventions for weight management in overweight and obese children on educational outcomes
- To assess the effectiveness of a paediatric primary care weight management programme on educational attainment (pilot study)

### **4.1. Introduction**

In this chapter I present the rationale, methodology and findings of study 2 which evaluated the effect of a primary care weight management programme on participants' educational attainment. In the study introduction I describe how this study relates to the previous study and its findings. I elaborate the contextual setting, methodological rationale, and outline the aims and hypothesis of this study. After presenting the methods and results I conclude this chapter by discussing the results and provide a study-specific conclusion.

#### **4.1.1. Study rationale**

Since observational research suggests that childhood obesity might be negatively associated with cognitive function and educational attainment (see Chapter 2.1 and 2.2) and lifestyle change intervention are recommended for treatment of overweight and obesity at a young age (NICE, 2013; SIGN, 2010; WHO, 2008), it might be plausible that lifestyle interventions also have beneficial effects on cognitive function and educational attainment in this population group (see Chapter 2.5 and Figure 2.3).

In the previous chapter I investigated the effect of lifestyle interventions on school achievement, cognitive function and later life achievements by synthesising evidence from randomised controlled trials (RCT) and conducting a meta-analysis of included studies where appropriate. Findings indicate that some cognitive and academic abilities can be improved in overweight and obese children after

participating in school-based obesity prevention and treatment interventions mainly focusing on physical activity behaviour. The Cochrane review revealed that evidence of the effect of lifestyle interventions on cognitive and academic abilities is lacking, particularly in the UK. Furthermore, to date, no study has investigated the effectiveness of an evidence-based child weight management programme delivered in primary care on educational attainment and/or cognitive function.

Compared to school-based interventions which typically target all children at school, primary care weight management programmes are specifically designed to address the needs of overweight children and their families in order to reduce overweight and to engage in a healthy lifestyle. Techniques such as motivational interviewing, self-monitoring, goal setting, problem solving, and stimulus control are recommended and applied for improvement of dietary and physical activity behaviour. These behaviour change techniques might also impact beneficially on cognitive abilities such as self-regulation, planning and problem-solving (Bruce et al., 2011) known to determine both weight management success and academic achievement. As reviewed in Chapter 2.5 there are other several mechanisms which may explain how a paediatric weight management programme can benefit educational attainment.

**Contextual rationale.** In 2012, the prevalence of overweight (BMI 85<sup>th</sup> percentile, relative to the UK 1990 reference standard) among children and adolescents aged 2-15 years in Scotland was 30.6%. This figure includes a proportion of obese children and adolescents of 16.8% (Bromley et al., 2013). Due to the high prevalence of childhood obesity reaching the highest numbers in 2008, with 36.1% of children being overweight, and the prediction that 40% of Scots will be obese by 2030, the Scottish Government introduced the Health Improvement, Efficiency, Access and Treatment (HEAT) targets (The Scottish Government, 2010). The HEAT target with regards to child healthy weight intervention is labelled H3 and sets out the number of children expected to complete a healthy weight intervention programme. The target is achieved when 14,910 children and adolescents completed such an intervention by March 2014. The rate of completion is defined as 75% attendance. In March 2012, 5,232 children across Scotland completed a child healthy weight intervention (ISD,

2013). The interventions are diverse, ranging from physical activity programmes for the general paediatric population, to multi-disciplinary lifestyle interventions in primary care or community setting for the whole family (ISD, 2013). According to Scottish Government Guidance, child healthy weight interventions should be completed by at least 40% of children and their families from the two most deprived local Scottish Index of Multiple Deprivation (SIMD) quintiles (ISD, 2013).

In the Scottish education system, there are five stages of schooling which are pre-school, primary school, secondary school, and vocational or higher education. Pre-school education is non-compulsory and offered to children aged 3 and 4 years, typically provided in nurseries attached to primary schools. The educational experience is play- and activity-based in open space settings where children are free to move between different areas. Educational activities which focus on literacy and numeracy are commonly offered as both adult led group activities or freely chosen activities (Dunlop, 2008). Compulsory primary education begins for children from the age of 4.5 - 5 years depending on the date of birth and lasts for seven years from primary 1 to primary 7. For the last 20 years primary and secondary education was guided by the 5-14 curriculum. Primary education was structured by the subject areas Mathematics, Language, Religious and Moral Education, Expressive Arts and Environmental Studies with suggested free time for play. In early primary school years, emphasis was given to teacher assigned individual literacy and numeracy tasks (Dunlop, 2008). From the age of 11 years children enter secondary school comprising six years of secondary education. The range of subjects taught is broad ranging from 'core' subjects such as English Language, History, Science, Mathematics, Chemistry, and Physics to more creative subjects including Art and Design, Music and Drama, and other 'optional' subjects such as Health Promotion, Physical Education, Outdoor Education, Home Economics and Business Education. During the first two years of secondary education children take the same subjects. From secondary 3 onwards children are offered a choice of subject combinations (columns) to choose from arranged in accordance with requirements for future employment or further and higher education (Boyd, 2008).

In 2004, the education system in Scotland experienced a curriculum change from the 5-14 curriculum guidelines to the Curriculum for Excellence (CfE). Both systems differ considerably in their teaching and assessment approaches. In the 5-14 curriculum the driver of learning is the gain of knowledge suggesting a goal oriented curriculum with the five guiding principles: continuity, progression, coherence, breadth and balance. On the other hand, CfE comprises the schooling age of 3-18 years instead of 5-14 years and follows a child oriented approach where the pupils take greater responsibility for their own learning. The guiding principles of the 5-14 curriculum were revised and extended for CfE including breadth, coherence, progression, challenge and enjoyment, personalisation and choice, depth, and relevance (Reid, 2008).

Assessment of educational attainment begins in primary school. Currently, two conflicting regimes exist; the grade-based assessment linked to predetermined criteria and Assessment is for Learning (AifL) where teachers provide meaningful feedback for learning which helps pupils to see how to improve their current understandings and skills (Bryce, 2008). 5-14 assessment comprised five attainment levels (A to F) where each level is defined by a number of targets achievable by a certain schooling stage. For example, level A targets should be attainable by P1-P3 pupils and level B targets by some P3 and most P4 pupils. Table 4.1 lists 5-14 attainment levels for each schooling stage. With the implementation of CfE, the five-level assessment of the 5-14 curriculum was reshaped into six levels reflecting outcome and experience - three levels for primary education ('early', 'first', 'second') and three levels for secondary education ('third', 'fourth', 'senior') (Reid, 2008).

**Table 4.1: Attainment by schooling stage in the 5-14 Curriculum and Curriculum for Excellence (CfE)**

Schooling Stages	5-14 Guidelines	CfE	Age (years)
Primary 1	Most working at level A	Early	4.5-5
Primary 2	Most working at level A	First	5-6
Primary 3	Some working at level B	First	6-7
Primary 4	Most working at level B	First	7-8
Primary 5	Most working at level C	Second	8-9
Primary 6	Some working at level D	Second	9-10
Primary 7	Most working at level D	Second	10-11
Secondary 1	Most working at level E	Third	11-12
Secondary 2	Some working at Level F	Third	12-14
Secondary 3	Most working at level F	Fourth	14-16
Secondary 4-6	SQA	Senior	16-18

**Methodological rationale.** For the investigation of the effect of a weight management service on educational attainment of overweight or obese children based in the UK, the study design with the highest quality of research would be a randomised controlled trial (RCT). However, creation of primary evidence by setting up a weight management intervention and measuring cognitive or educational abilities was not feasible within the scope of my doctoral research due to ethical concerns, high costs and potential inefficiency. In addition, although there are ongoing weight-management programmes in Scotland, approaching participants for involvement in research may influence participation in weight management negatively and may cause attrition from the treatment programme. Therefore getting access to participants of ongoing treatment programmes can be problematic.

Therefore, the use of existing data from a weight management programme and education data obtained from school records (i.e. administrative data) appeared best suited to investigate the effect of a primary care child weight management programme on educational attainment. Use of existing data also ensures that the research is unaffected by the Hawthorne effect, a phenomenon where study

participants may start to improve/change their behaviour when they know they are being studied (Diaper, 1990).

Administrative data are information that is routinely collected during service provision. The collection of education data is regulated by statutory guidelines which govern the type of information schools are expected to hold about their pupils (Davies et al., 2010). In Scotland, administrative education datasets are, for example, Pupils in Scotland Census and the Scottish Qualification Assessment (SQA) Examination Results in Scottish schools. The school census data are gathered by local education authorities covering all independent, grant-aided, self-governing and local authority schools (The Scottish Government, 2013c). Administrative health datasets are, for example, the Hospital Episodes Statistics held by NHS England and the Scottish Morbidity Record held by NHS Scotland. Both datasets contain information of patients in secondary health care (e.g. hospital admission, treatment, death). Administrative datasets of primary health care exist at places but do not cover all primary care providers. The General Practice Research Database (NHS England) is an example of an administrative dataset in primary health care (Garratt et al., 2010).

Administrative data have great potential for research since they provide a relatively cost-effective, less intrusive and comprehensive resource (Gorard, 2012). Education and health based administrative datasets have been used for a variety of research projects including the following research topics: policy evaluation, assessment of interventions and treatments, evaluation of cost-effectiveness, influence of external events on health and education, investigation of inequality, comparison of providers and regional variation, identification of trends in healthcare and education, and prediction of future outcomes (Davies et al., 2010; Garratt et al., 2010).

An even further benefit of the use of administrative datasets can be achieved by linking different administrative datasets between and across sectors. Data-linkage can improve the value of existing data, enables low-cost retrospective and prospective longitudinal research, increases the capacity to evaluate efficiently programmes and provides a potential system to answer sophisticated, currently



unknown research questions (Taylor & Lynch, 2010). Data linkage is defined as the bringing together of data from two or more different sources that relate to the same individual, family, place or event (Hobbs & McCall, 1970). In the Scotland-wide Data Linkage Framework data linkage is understood as “the joining of two or more administrative or survey datasets to greatly increase the power of analysis then possible with the data.” Within the Framework data linkage is used for statistics and research purposes only to understand groups or populations as opposed to identifying or directly impacting on any individual. (The Scottish Government, 2012b).

However, linking and accessing personal data may be cause for concern regarding privacy protection. To ensure security and low risk to privacy the stages of data linkage need to be organisationally and physically separated, require the use of personal information for the minimum amount of time, require restricted access of data, and the transfer of data only through secure file exchange. Difficulties to access linked data might be due to limited access and capacity of existing data sharing facilities, variation in the interpretation of the legal and regulatory environment which can affect approval of data release for data linkage (The Scottish Government, 2012b). Another barrier to the use of linked data for research might be the quality and consistency of existing administrative data systems.

To date, well-established data-linkage and data-sharing systems in the UK include the Oxford Record Linkage Study, the Scottish Record Linkage System, the Scottish Informatics Programme (SHIP), and the Secure Anonymised Information Linkage (SAIL databank) in Wales (Taylor & Lynch, 2010). These data-linkage systems are used for surveillance and need analysis, aetiologic research, service utilisation research, service outcome research, and methodological research. Data-linkage systems are complex data holding environments containing large numbers of data sources available for linkage for an undefined time period. Administrative data are held for any kind of research project and the actual research questions are unknown at the time of data-linkage. On the contrary, the type of data-linkage where administrative data are sourced and linked for a specific research project is called ad-hoc data-linkage. The number of sourced data is limited and access to linked data is only possible for the duration of the research project.

Currently, there are four cross-sectorial data linkage studies taking place in Scotland which combined health records with records from social care, Census data and education data.

The Scottish Health and Ethnicity Linkage Cohort Study (SHELS) linked information on individual ethnic groups from the 2001 Census to Scottish hospital discharge and mortality data. Individual data were linked based on name, date of birth and address (Fischbacher et al., 2007). This study aimed to investigate the association between ethnic groups in Scotland and postnatal characteristic (e.g. birth weight, breastfeeding), cancer development (lung, breast, colorectal, prostate), cardiovascular diseases (e.g. myocardial infarct, chest pain, stroke), and respiratory (e.g. asthma), gastrointestinal and mental health (e.g. depression).

Using functional outcome data on elderly after rehabilitation obtained from the Tayside Health Informatics Centre (HIC) and linking them with social services data held by Dundee City Council, Whitham and colleagues are currently about to explore “future dependency, social service use and institutionalisation and the effect of medications on the trajectory of functional decline” (Whitham, 2012).

Wilson et al. (2013) aimed to investigate early childhood emotional and cognitive development and existing means to improve and evaluate services for optimal child development at pre-school age. This aim was achieved by linking research data sets of cognitive and developmental outcomes with administrative data obtained from maternal birth records (Scottish Medical Records) and Child Health Surveillance Data (Pre-school). Data linkage was performed by authorised personnel at the Information Division Service (ISD, Scottish Government) based on identifying personal information, and data sets were anonymised prior to provision of data to the researchers (Wilson et al., 2013).

An example of cross-sectorial data linkage using health and education data is the study by McKay et al. (2010) in which 2003 School Census data were linked via birth certificate data with the Scottish Morbidity Record containing individual level obstetric data (MacKay et al., 2010). Researchers aimed to explore the risk of special educational needs in relation to gestational age, mode of delivery and other pregnancy characteristics. Based on findings of this study, researchers up-scaled this study linking 2006-2011 School Census records with SQA examination results

(2006-2011), the School leaver destination survey (2007-2011) and the Scottish Morbidity Record (Pell et al., 2012).

In summary, linking existing data sets within either the health or education sector is becoming common practice in the UK. Less common and currently under investigation and development is the data linkage across sectors, for example data-linkage of administrative health and education data. Given the potential barriers of data-linkage, to my best knowledge, it is unknown whether it is feasible to link primary care weight management and education data aiming to investigate the effect of childhood overweight treatment on educational attainment.

#### **4.1.2. Aims and Hypotheses**

Since there is no evidence available on the relationship between a UK based primary care weight management programme on educational attainment and, to date, existing data linkage systems in Scotland do not hold the type of data required to investigate the effect of weight management on educational attainment, the aims of this study were as follows:

- 1) To assess the feasibility of performing a data-linkage study which combines administrative data collected by a childhood weight management service and educational data collected by local authorities
- 2) To assess the effectiveness of a UK based primary care child weight management programme on educational attainment
- 3) To inform the design of a larger definitive, pragmatic study which will investigate the impact of weight reduction programmes on the educational achievements of children

I hypothesise that it is feasible to perform a data-linkage of routinely recorded, independent datasets from a primary care childhood weight management service and education authorities in Scotland. Furthermore, I hypothesise that the participation in

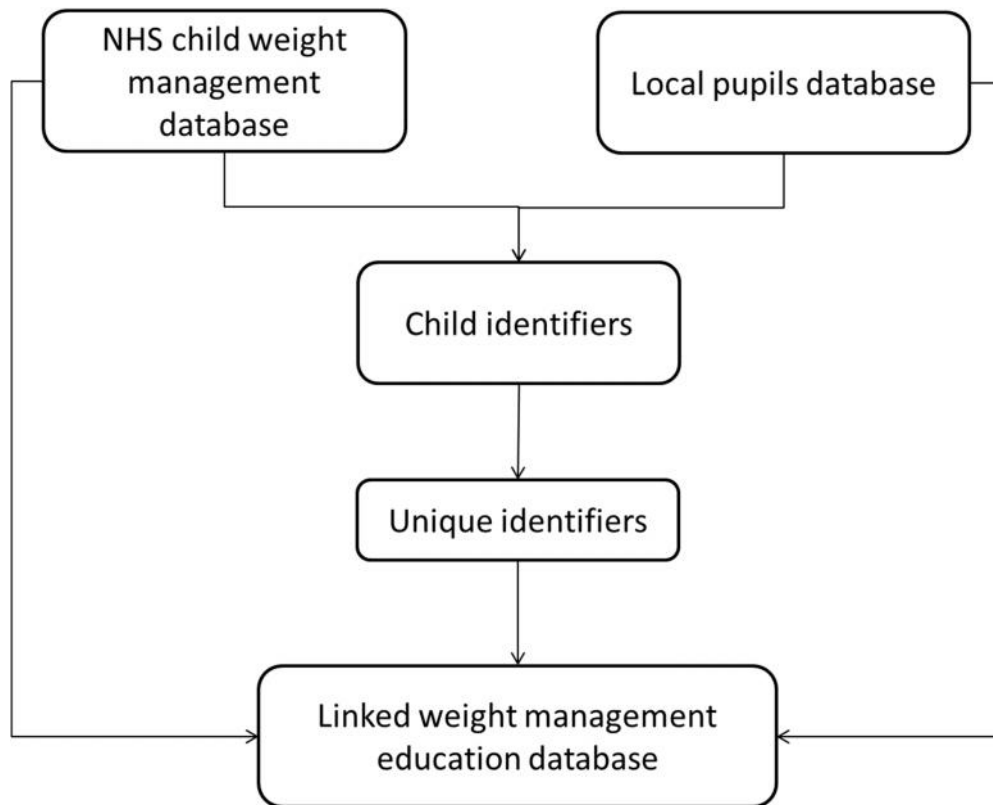
an overweight treatment program improves the educational attainment in overweight and obese children.

## **4.2. Methods**

### **4.2.1. Study design**

This study followed a pragmatic, quasi-experimental study design. Herein, the term ‘pragmatic’ refers to the secondary analysis of existing data collected outside the research environment during the course of service provision. For this study an ad-hoc data linkage has been performed linking administrative school data with primary care child weight management data (Figure 4.1).

To meet the objectives of this study – assessing feasibility and effectiveness – two distinctive study designs have been applied. First, a feasibility study was conducted which is understood as a study that can generate helpful means to inform effective methodology and study protocols leading to full-scale research. Second, to investigate the effect of childhood weight management on educational attainment, a quasi-experimental controlled pre-/post-intervention design was applied. This design may allow examination of the trend and changes of the participant’s educational attainment before and after participation in a childhood weight management programme. To increase the confidence that the effect on educational attainment is due to the weight management programme and not due to an event that occurred with the onset of the intervention, data from children who were referred but did not opt in to the weight management programme were treated as control group for comparison against data of children who dropped out of or completed the weight management programme (intervention group).



**Figure 4.1: Flowchart of ad-hoc data-linkage of a child weight management database and local pupil databases**

#### **4.2.2. Intervention characteristics**

This study was conducted using data from the Paediatric Overweight Service Tayside (POST, NHS Tayside) which was developed in accordance with the HEAT target H3. POST offers childhood weight management service for children aged 2-15 years at the Perth Leisure Pool, Kirkton Community Centre in Dundee and Saltire Leisure Centre in Angus. The roll-out of POST started in the NHS Tayside area of Perth and Kinross Council in May 2009. In September 2009 POST was available for families in the NHS Tayside areas of Dundee Council and Angus Council. For this feasibility study the POST database contained participant data updated until June 2012.

POST is based on the Scottish Childhood Overweight Treatment Trial (SCOTT). The efficacy of SCOTT was tested in a RCT and regarded as a successful family-centred childhood weight management programme to promote behaviour change towards a

healthier diet, increased physical activity and reduced sedentary behaviour (Stewart et al., 2005, Hughes et al., 2008).

Families are referred to POST either by general practitioners, community paediatricians, school nurses, health visitors and other health professionals or they are self-referred. Children and families with the following criteria are eligible to participate in POST:

- Children aged 2-15 years
- Body mass index 91<sup>st</sup> percentile (relative to the 1990 UK reference population), i.e. clinically considered as overweight
- Parents/carers motivated to participate.

POST offers two lifestyle intervention programmes to motivated families. One programme is called SCOTT targeting children aged 8 years and older and the other programme is SCOTTLite aimed at children under the age of 8 years. SCOTT consists of ten appointments (eight treatment and two follow-up sessions) with two parents/carer only sessions over four to five months. SCOTTLite is designed to meet the families over three to four months in six treatment and 2 follow-up appointments which include three parents/carer only sessions. The SCOTT and SCOTTLite interventions are delivered in one-to-one sessions (i.e. one practitioner for one family) each lasting 30-60 minutes.

Paediatric dietitians and physical activity instructors educate on positive lifestyle changes and enable the child and his/her family to take ownership of behaviour change. Participants are familiarised with the principles of a balanced healthy diet using the “traffic light” approach (Stewart et al., 2005). Food rich in fat and sugar is labelled red and children are encouraged to eat one red food per day in the long term. As amber food are considered protein (meat) and starch (e.g. bread, pasta) rich food and dairy. These food types are advised to be consumed in moderation. Fruit and vegetable based food and sugar-free drinks have a green label and should be eaten primarily and regularly. Physical activity instructors encourage the family through counselling to be active one hour per day and to reduce the time spent watching television or playing computer/video games to less than two hours

per day. The behaviour change techniques used to achieve the aforementioned targets include motivational interviewing, exploration of advantages and disadvantages of behaviour change, goal-setting, self-monitoring using a lifestyle diary, identification of barriers, problem solving, relapse prevention and social support.

### **4.2.3. Participant inclusion criteria**

Inclusion criteria for feasibility and effect assessment:

- Data of children and adolescents aged 5-18 years who were referred to POST
- Children have entered primary school at referral to POST.

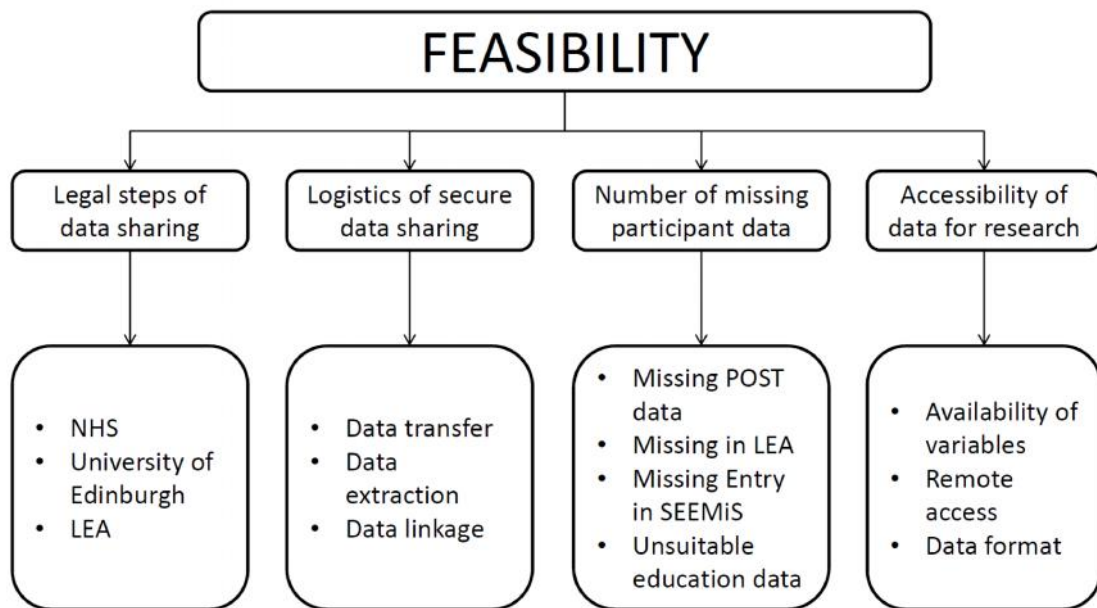
Additional inclusion criteria for the analysis of the effect of the programme on educational attainment were formulated:

- Both, POST and education data could be successfully linked on the individual level
- Available pre and post-treatment 5-14 attainment data in at least one of the assessed subjects (i.e. mathematics, reading, writing).

### **4.2.4. Measures**

#### **Feasibility measures**

Four higher level feasibility measures were assessed of which each was explored in-depth by creating three to four lower-level feasibility measures. The higher level feasibility measures are i) legal steps of data sharing, ii) logistics of secure data sharing, iii) number of missing participant data, and iv) accessibility of data for research. Feasibility outcomes were chosen on the basis of their potential to inform the design of a definitive study. Figure 4.2 illustrates the higher and lower level feasibility measures assessed.



**Figure 4.2: Feasibility measures flow chart.** NHS: National Health Service, LEA: Local Education Authority, POST: Paediatric Overweight Service Tayside.

Feasibility data were obtained through field notes and an open-ended questionnaire. The questionnaire contained four specific questions aimed at the Information Officers at the Local Education Authorities (LEA) and our collaborators at the Health Informatics Centre (HIC) and was distributed and returned by email. The questions were as follows:

*A Questions to the Information Officers at the LEA*

1. How did you identify the POST children in SEEMiS?
2. Was it possible to find all POST children based on the selected identifiers?
3. How long (working hours or days) did it take to extract all data and prepare the data file for transfer to HIC?
4. What steps were involved from receiving the identifiers from HIC to sending the file to HIC?



## *B Questions to HIC collaborators*

1. How were the PROCHI numbers<sup>1</sup> generated and further anonymisation of data items performed?
2. How were the data transferred between POST and HIC, and HIC and LEA?
3. Where there any issues that you would consider as difficult/challenging or very time consuming in relation to the data transfer and data sharing? If yes, please state which ones.
4. On a scale from 0-10 how would you rate the feasibility of this data-linkage study with 10 indicating “very feasible”?

Since both administrative datasets from POST and local education authority are large and complex, only study relevant data were requested, extracted, supplied and accessed. By specifying the required data items prior to data extraction, the time of data provision and size of the datasets was potentially minimised, which potentially made data storage and processing easier. No additional information obtained from measurements, tests, interviews or completion of questionnaires was collected.

### **Administrative POST NHS data**

All information regarding the participation in POST was obtained from the POST NHS database. Participant data were collected from referral to the treatment programme until completion, including follow up assessments where applicable. The POST NHS database covered participant information from the time of POST implementation in 2009 until June 2012. The following administrative data item were available and extracted from the POST NHS database:

---

<sup>1</sup> Arbitrary acronym which refers to the unique individual identifier generated from children's Community Health Index (CHI) number

a) Socio-demographic data

- Age at referral
- Gender
- Scottish Index of Multiple Deprivations (SIMD) quintiles
- Area of programme delivery

b) Treatment-specific data

- Diagnosed disabilities
- Programme entry date
- Type of the programme (SCOTT/SCOTTlite)
- Opt-in status
- Number of attended appointments
- Percentage of attended appointments
- Pre- and post-treatment body mass index (BMI)
- Pre- and post-treatment BMI standard deviation scores
- Pre- and post- treatment BMI centiles
- Pre- and post-treatment Pediatric Quality of Life [PedsQL™] scores

Child's name, date of birth, gender, address, weight and height at referral, and referral date were provided with the referral letter or obtained directly from the child's family when the child was self-referred. In the POST database age is entered in decimal age in years. Further medical information such as diagnosed disabilities was available from the general medical records. The following measures are derived or measured by POST practitioners.

Socioeconomic status of the child's family was estimated using the postcode to determine the Scottish Index of Multiple Deprivation (SIMD). SIMD measures area deprivation and combines 38 indicators across the domains of income, employment, health, education, skills and training, housing, geographic access and crime. SIMD was categorised into quintiles where the first quintile indicates the most deprived areas and the fifth quintile indicates the least deprived area (The Scottish Government, 2012a).

Also based on participants address and postcode the area of programme delivery is reported which could be Angus, Dundee or Perth and Kinross.

Based on the child's age, POST practitioners recorded which of the two POST programmes the child is allocated to. They also recorded whether a referred child opted in to the programme or not and the number of attended sessions. The completion rate for each child is determined using the 75% programme completion cut-off set by the Scottish Government. For example, children who attended at least 75% of the sessions (four sessions in SCOTTLite, six sessions in SCOTT) are considered to have successfully completed the programme.

Success of behaviour change in POST is estimated by the maintenance of body weight which results in a subsequent decrease in BMI and BMI standard deviation score (SDS). At the second and last appointment, children's weight and height were measured by trained practitioners according to clinical standard protocol. Weight was measured without shoes in light clothing using an annually calibrated portable digital scale (Seca Model 899, seca Ltd, Hamburg, Germany). Height was measured without shoes using the Leicester stadiometer (Seca Ltd, Hamburg, Germany). Weight and height measures were converted into age and gender-specific BMI standard deviation score (BMI-SDS) and BMI percentiles using the computing programme LMSGrowth provided by the Child Growth Foundation (<http://www.healthforallchildren.com/?product=lmsgrowth>). Derived BMI-SDS and BMI percentile values are relative to the 1990 UK references population.

Finally, change of children's quality of life is assessed by applying the validated and widely used Paediatric Quality of Life (PedsQL)<sup>TM</sup> questionnaire before and after the intervention (Varni et al., 2003). The PedsQL<sup>TM</sup> consists of a parent report of child's quality of life and a questionnaire for children to answer. The child questionnaire is available for three age groups; 5-7 years, 8-12 years, and 13-18 years. The dimensions assessed are physical functioning, emotional functioning, social functioning, and school functioning. Combination of the latter three dimensions yields in a psychosocial health score. The physical health score reflects the results of the physical functioning assessment. The mean and standard deviation scores for a healthy child are 83.9 and 12.5, for an acutely ill child the mean score is 77.7 with a standard deviation of 14.0, and for a chronically ill child the mean quality

of life score and standard deviation is considered to be  $74.2 \pm 15.4$  (Varni et al., 2003).

### **Administrative education data**

Administrative education data were obtained from the education database SEEMiS hosted by the local authorities in Tayside. Schools and teachers started using SEEMiS since the school year 2007/2008. Available administrative education data include data up to the school year 2012/2013. Pupils' education data were collected before and after POST participation; if available, from the time of primary school entry until graduation from secondary school. The following administrative data items were requested and extracted:

#### **a) Socio-demographic data**

- Receipt of free school meals
- National identity
- Ethnicity
- Scottish Candidate Number/ SEEMiS ID
- Main language spoken at home (first language)

#### **b) Education-specific data**

- School identifier (Cost Centre Code for each school)
- Type of school (primary/secondary/special)
- 5-14 attainment history in mathematics, English reading and writing
- Number of absent openings<sup>2</sup>
- Number of authorised absent openings
- Number of unauthorised absent openings
- Number of openings excluded
- Exclusion circumstances and motivation
- Level of English proficiency

---

<sup>2</sup> Pupils' attendance is recorded twice a day, at the start of the day (first opening) and after lunch (second opening).

- Looked after status<sup>3</sup>
- Assessed disability
- Declared disability
- Physical adaption required
- Curriculum adaption required
- Communication adaption required
- Individual Education Plan
- Coordinated Support Plan

All information available in SEEMiS was entered by teachers and school administrators. Educational attainment was teacher assessed in accordance with the 5-14 attainment curriculums. Besides educational attainment, all data items were recorded for the annual national School Pupil Census and thus measures were nationally agreed by schools from all LEA's and consistently reported. Data items not recorded by teachers were: looked after status<sup>3</sup> of children, disability, and physical, curriculum and/or communication adaption. The looked after status is compared with the Social Work MIS system and updated in SEEMiS on a monthly basis. Disability status (yes/no) and requirement of a physical, curriculum and/or communication adaption was assessed by a suitably trained professional. This information was then provided to the LEA.

Using the available data items I derived additional variables which included:

- Meeting national attainment expectations
- Attainment progress over time (pre and post-referral to POST)
- Number of total absent days per school year
- Number of authorised absent days per school year
- Number of unauthorised absent days per school year
- Time (months) between attainment awarded and referral to POST

---

<sup>3</sup> Looked after status refers to whether a child is looked after by the state according to relevant national legislations. A child is looked after when parents or carers are unable to care for the child or the child has committed an offence. The child can either be looked after away from home or at home.

As described in the introduction section of this chapter, 5-14 national assessment covered six levels of educational attainment (levels A-F). I considered educational attainment as binary variables converting attainment levels to whether a child met the national attainment expectation for the schooling stage assessed or not. The reasons for dichotomising educational attainment were i) this might be a meaningful outcome for practical implications and ii) the linked databases contained data of children at varying ages and thus schooling levels. Whether a child meets the attainment expectations or not allows comparison of attainment between children controlled for stage of schooling. Attainment levels A-F reflected at which schooling stage a certain level is attainable by most or some children according to the developmental stage. For example, level A is attainable during the course of P1 to P3 by most pupils. Children in P1 to P3 with a reading level A meet the attainment expectations but a pupil in P5 with a reading level A would not meet the reading attainment expectations. Table 4.2 shows the coding of attainment expectations for pupils in P1 to S3.

**Table 4.2: Attainment expectation by attainment level and schooling stage**

<b>Attainment level</b>	<b>Meeting expectations</b>	<b>Not meeting expectations</b>
Level A	P1-P3	P4
Level B	P4	P5
Level C	P5-P6	P7
Level D	P7-S1	S2
Level E	S2	S3
Level F	S3	Not applicable

When comparing educational attainment before and after the weight management programme, it is important to consider that some children may not meet national attainment expectations, but it is still possible that the children progressed from one attainment level to the next higher level. To assess the effect of the intervention on children's individual attainment progress, I derived the categorical variable

‘attainment progress’ for each of the subjects mathematics, reading and writing with three possible outcomes. The categories were no progress, progress by one attainment level (e.g. from A to B), and progress by at least two levels (e.g. from A to C or higher) between two consecutive academic years.

School absenteeism is derived from failed school attendance which is recorded twice a day, at the start of the day (opening 1) and after lunch (opening 2). There are 378 possible attendance sessions in a year which is equivalent to 189 attendance days per year.

#### **4.2.5. Data management**

##### **Data transfer and linkage**

The service of the Health Informatics Centre (HIC) were used which is a research support unit at Dundee University and which is set up on behalf of NHS Tayside. HIC provides data safe haven facilities for researchers to obtain secure access to data in accordance with the Scottish Health Informatics Programme governance principles. POST NHS data and education data were transferred in encrypted form to HIC and released to its safe haven facilities in separate files where I merged the two sets of administrative data (Figure 4.3).

##### **Data storage**

During the study all personal data sourced from the POST NHS database and SEEMiS were securely stored at the central server of the Health Informatics Centre (HIC). At no time originally sourced data were stored on Edinburgh University computers or researchers’ laptops. Data were stored; quality assured and processed in secure areas accessible only for authorised HIC staff. All HIC processes were performed according to the HIC Standard Operating Procedure.

At the completion of the study all research data will be removed from the HIC server and securely archived off-line by the HIC System Administrator. After 12 years data will be disposed.

### **Data access and confidentiality**

Confidentiality was assured by allowing access to identifiable data only by authorised personnel from both the NHS Tayside and Local education authorities. Data were anonymised by a HIC Data Analyst prior to release to the safe haven and access by the researchers. Any data exported for publication will therefore not contain any identifiable participant information.

### **4.2.6. Data analysis**

I performed the analyses of data remotely on the secure HIC server. Removal of data from the secure central server was only possible after clearance by a HIC Data Analyst that analyses results do not contain identifiable participant information. Analyses were performed using Stata 11 statistic software (StataCorp, 2009).

### **Feasibility assessment**

Feasibility measures were analysed and reported descriptively. Missing and/or available data were reported in frequencies and percentages.

### **Effect of childhood weight management on educational attainment**

In order to explore the effect of participation in POST on children's educational attainment the following analyses were conducted:

- Summary statistics of participant characteristics
- Comparison of pre-intervention (baseline) participant characteristics between the three comparison groups (i) not opted in to POST, (ii) POST not completed, (iii) POST completed
- Assessment of changes in educational attainment measures over time within each comparison group (see above)
- Comparison of post-treatment attainment measures between the three completion groups
- Number of attended POST sessions as predictor of educational attainment



**Participant characteristics.** Participant characteristics were summarised as means and standard deviations for normally distributed data, medians and minimum-maximum ranges for non-normally distributed data, and frequencies and percentage for categorical measures. Normality of continuous data was determined using the Shapiro-Wilk-test. The null hypothesis that data follow a normal distribution was rejected when the significance level was less than 5%, i.e.  $<0.05$  indicated that data were not normally distributed.

**Pre-intervention group comparison.** Since allocation into comparison groups (group 1: not opted-in, group 2: not completed, group 3: completed) was not done randomly, differences in participants' pre-intervention characteristics need to be determined. Whether participants of each group differed significantly was assessed using Fisher's exact test, one-way analyses of variance (ANOVA), and Kruskal-Wallis Test for categorical, normally distributed and for non-parametric continuous data, respectively. The significance level was set at 5% ( $<0.05$ ) for all analyses. No significant differences in participant characteristics may suggest that the three groups are comparable and differences in the outcome might be due to the experimental conditions and less likely due to other influencing factors.

**Within-group changes over time.** For the assessment of changes in meeting attainment expectations before and after the intervention within each comparison group I used McNemar's test for paired binary data. McNemar's exact test was used when 'exposure/control' cells had less than five observations and McNemar's  $\chi^2$  test was performed when cells showed at least five observations. For assessment of changes in attainment progress over time within each comparison group Wilcoxon Signed Rank Test was used for non-parametric (ordinal) paired data.

**Between-group differences post-treatment attainment.** Since available data were from children who attended different schools in different local education authorities, a hierarchical structure of the data could be assumed where children are nested within schools. I tested the effect of schools on binary educational attainment

variables using a two-level null model (without predictor variables). The model is described in the following equation;

$$\log\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = \beta_0 + u_{0j} \quad (4.1)$$

Where  $\log(\pi_{ij}/(1-\pi_{ij}))$  is the log probability that pupil  $i$  in school  $j$  meets the attainment expectations,  $\beta_0$  is the overall mean across schools,  $u_{0j}$  is the effect of school  $j$  on attainment expectations.

There was no school effect on any of the outcome variables. The  $\chi^2$  value of the likelihood ratio statistic did not exceed 3.84 which indicated no significant school effect on educational attainment. The likelihood ratio test compared the likelihood value of the two-level null model with the single-level model (school identifiers as predictor variable only). Therefore, single-level models were fitted to assess the effect of child weight management (POST) on educational attainment, comparing post-treatment attainment expectation the “not opted-in” group and the “not completed group” and between the “not opted-in” group and the “completed” group.

For meeting attainment expectations as response variable, three different binary logistic regression models were fitted; one for each school subject (mathematics, reading, and writing). The equation of the logistic model included is as follows;

$$\log\left(\frac{\pi_i}{1-\pi_i}\right) = \beta_0 + \beta_{1i}x_{1i} + \beta_{ni}x_{ni} \quad (4.2)$$

Where  $\log(\pi_i/(1-\pi_i))$  is the log probability that pupil  $i$  met the attainment expectations,  $\beta_0$  is the regression coefficient for not meeting the attainment expectations,  $\beta_1$  is the regression coefficient for comparison groups,  $x_1$  is the effect of the comparison groups,  $x_n$  is a vector for regression coefficients and effects of control variables.

Since the sample size was low, likelihood ratio tests were used to determine model fit after control variables were entered. Multicollinearity between predictor and control variables was assessed and considered when fitting the regression models.

**Number of attended POST sessions as predictor variable.** For assessment, whether meeting attainment expectations is a function of number of attended sessions, I also used logistic regression models for mathematics, reading and writing attainment as response variables. The model equation is similar to (4.2); only that  $\beta_1$  represents the regression coefficient for number of attended session and  $x_1$  is the effect of number of attended session.

Multicolliniarity between control variables was considered and significance of models was assessed using Likelihood ratio tests.

### **Multiple imputation of missing values**

Described in detail in the result section of this chapter, the linked dataset contained missing values for some response and predictor variables. Missing data were estimated using multiple imputation (MI), in which missing values were replaced by a set of plausible values for missing values based on the appropriate probability distribution of observed (available) data (White et al., 2011). I explored the reasons for missing data and missing data were assumed to be missing at random. This means that the probability that data are missing does not depend on unobserved variables but may depend on observed variables and thus can be controlled for when estimating missing data. For example, missing attainment measure in one subject but not the others for the same child could be related to missing school-level regulations on which data should be entered in the education database. Since school identifiers are available, the reason for the missing data can be controlled for.

MI was shown to perform well with small sample sizes and high proportions of missing values as high as 50% (Graham, 2009). Imputation of missing values higher than 50% of missingness increases the likelihood of introducing errors and imprecision. Multiple imputations are superior to complete case analyses (listwise deletion) as it does not discard all observation with missing values. In complete case analyses all information contained in the non-missing values of observations are

subsequently lost. This leads to less efficient results compared to findings based on multiply imputed datasets. The results are low in power, show larger standard errors and wider confidence intervals and are prone to bias (Graham, 2009).

I used the multiple imputation with chained equations (ice) option (Royston, 2009) in Stata 11 (StataCorp, 2009). Imputation of missing values was a three step process started with imputing the missing values and creating multiply imputed data sets. The second step involved the analysis of completed-data sets and in the third and final step all completed-data sets were combined and estimates were pooled using Rubin's (1987) combining algorithm (Rubin, 1987).

Multiple imputation required two model specifications; one imputation model and an analysis model. Both models differed from each other. The imputation models included all variables likely to be explored in the analysis step and all predictor variables that were relevant to the missing-data mechanism. For example, missing post-treatment reading attainment levels were estimated using an ordinal logistic regression model which included the variables schooling stage, school identifier, post-treatment writing level, pre-treatment BMI-SDS, gender, absent days, and number of sessions attended. Categorical post-treatment attainment data were derived after imputation was completed from attainment levels. All imputation models used for each imputed variable are listed in Appendix 8.3.7. The number of multiple imputations and thus the number of complete data sets was 35 determined by the proportion of incomplete cases (34.2% - for 13 cases pre/post-treatment writing attainment was missing) as recommended in the literature (White et al., 2011).

Findings of the complete case analyses and analyses with imputation of missing data are presented in the following section of this chapter.

### **4.3. Results**

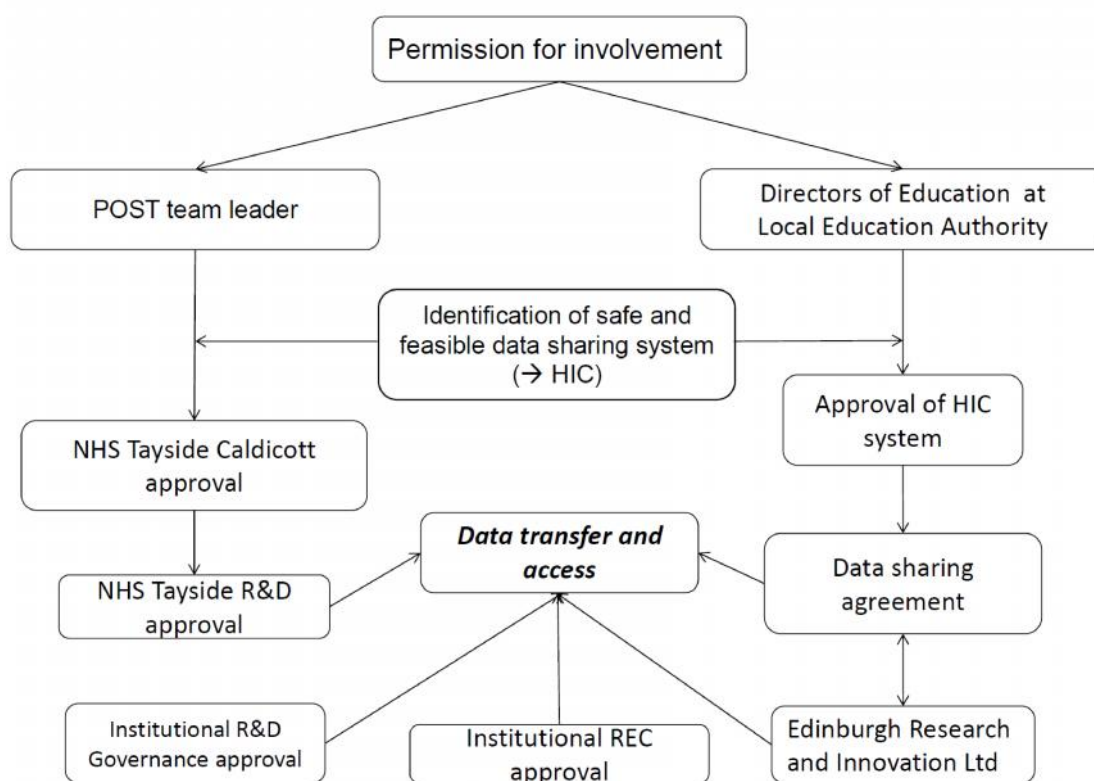
In this section I present the findings of my second study in two parts relating to the aims of this study. The aims of this study were to assess the feasibility to perform a cross-sectorial data-linkage of administrative NHS primary care child weight

management and education data and to assess the effect of child weight management on educational attainment. I have applied qualitative methods to evaluate the feasibility of this study, and hypothesis testing and statistical regression methods to address the secondary aim of this study.

#### 4.3.1. Feasibility of linking weight management with education data

##### Legal/ethical steps of data sharing

Figure 4.3 shows the authorities from where permissions and approvals for legal and ethical reasons had to be obtained prior to access, linkage and analysis of data for this study. Permissions and approvals had to be obtained from three authorities: NHS Tayside, Tayside Local Education Authorities, and the University of Edinburgh. Getting all permissions and approvals in place was a very time consuming process. The first permissions of involvement in this study were given in November 2011 and in March 2013 all agreements were signed and data could be shared.



**Figure 4.3: Study approval flow chart.** POST: Paediatric Overweight Service Tayside, NHS: National Health Service, R&D: Research and Development Office, REC: Research Ethics Committee, HIC: Health Informatics Centre.

**Access to NHS Tayside patient data.** Since POST is an NHS Tayside primary care weight management programme, access to data of children who were referred to POST needed to fulfil NHS Tayside legal and ethical standards.

In contrast to most clinical research involving children and adults this study did not required review by a research ethic committee (REC) within the UK Health Departments Research Ethics Service because the research is ‘limited to use of previously collected, non-identifiable information’ collected during the course of service provision. However, use of non-identifiable data occurs only at the stage when the researchers accessed the data for further analysis. Prior to that, the study required the access to identifiable data such as participants’ names, date of birth, addresses, and post codes to identify the children in the education database (SEEMiS) of Tayside Local Education Authorities.

Identifiable data are personal information and their distribution and access is protected by the UK Data Protection Act from 1998. The protection of identifiable information of NHS patients lies in the responsibilities of Caldicott Guardians who review data access applications to govern disclosure and use of personal information. Caldicott approval and subsequent NHS Tayside Research and Development (R&D) approval (Appendix 8.3.1 and 8.3.2) for this study was given on the basis of the following conditions:

- 1) secure data transfer and storage for identifiable data is assured by an NHS Tayside approved data hosting system,
- 2) the researcher obtained a Letter of Clinical Access for “Access to identifiable patient data derived from health records, tissues or organs with no likely impact on prevention, diagnosis or treatment”.

Secure data transfer, storage and access were fulfilled by using the service of the Health Informatics Centre (HIC) which is a research support unit at Dundee University set up on behalf of NHS Tayside. HIC provides data safe haven facilities for researchers to obtain secure access to data in accordance with the Scottish Health Informatics Programme (SHIP) governance principles (SHIP, 2010). HIC works under NHS Tayside approved standard operating procedure. A Data User Agreement was signed between HIC and Dr David Saunders (supervisor) and myself at the Institute for Sport, Physical Education and Health Sciences, University of Edinburgh (Appendix 8.3.4). To meet the second condition I obtained a Letter of Clinical Access from the NHS Tayside R&D.

**Access to educational data of identified POST participants.** Identification of pupils who participated in POST on the basis of personal identifiers was performed by Information Officers of relevant local authorities. This study required further sensitive and personal information such as ethnicity, looked after status, and educational attainment obtained from the education data base SEEMiS. Provision of the above information was possible without seeking direct consent and assent from parents/guardians and children, respectively. The legal foundation for this was an existing data sharing consent statement signed by parents or guardians when applying for attending a Tayside LEA school. The data sharing statement form stated that data will be shared with third parties (e.g. NHS Tayside) in order to improve service delivery. The findings of this pilot study and potential definite studies may contribute to the improvement of the educational environment of overweight and obese children and youth. Hence parents/guardians consented indirectly to the use of their child's sensitive and personal education data for this study.

Identifiable sensitive and personal education data were transferred to HIC (NHS Tayside Health Informatics Centre). Researchers received permission from the LEA to access anonymous data only. A Data Sharing Agreement between the University of Edinburgh and the LEA was required prior extraction of data from SEEMiS and transfer to HIC (Appendix 8.3.5 and 8.3.6). Identifiable data obtained from SEEMiS were anonymised by HIC prior to data access by the researchers.

The Directors of Education from all the Tayside Councils (Dundee City Council, Angus Council, Perth & Kinross Council) gave permission to be involved in the study. However, the data sharing consent statement signed by parents and guardians of children attending a school in Perth and Kinross did not explicitly state the possibility of data sharing with third parties for service improvement. This prevented us from accessing education data without seeking direct consent from parents. Contacting these families directly was not considered as ethical and practical by the NHS Tayside due to disclosing personal information to an unauthorised party (i.e. the researchers). Thus data sharing with the LEA of Perth and Kinross was not possible.

**Approval of institutional involvement.** For this study to be conducted within the University of Edinburgh approval from the following institutions were required:

- Institutional research ethics committee
- University of Edinburgh Research Governance Office
- Edinburgh Research and Innovation Ltd

This study was reviewed by the institutional research ethics committee of the Moray House School of Education, University of Edinburgh. Since this study is a data-only study it received Level 1 approval which “covers research with participants that is ‘non-problematic’, i.e. the likelihood of physical or emotional risk to the participants is minimal. This may include, for example, analysis of archived data, classroom observation, or questionnaires on topics that are not generally considered ‘sensitive’. This research can involve children or young people, if the likelihood of risk to them is minimal.”

Furthermore, the study was reviewed and approved by the University of Edinburgh Research Governance Office since the University of Edinburgh functioned as Sponsor (i.e. taking responsibility for design, conduct and management of the research) in research involving NHS patients.

Finally, sharing data with Local Education Authorities through Data Sharing Agreements required approval of the study and subsequent signature of the legal documents by the Edinburgh Research and Innovation Ltd of the University of Edinburgh.



### **Logistics of secure data sharing**

**Data extraction.** I extracted and double checked relevant data items from the POST NHS database (CHI numbers and addresses removed) and added missing data while being physically present at the POST NHS premises. POST kept their patient information in an excel file which made the data extraction and preparation less difficult. Extraction of data items and preparation of the dataset required five working days. After transfer of the data extract to HIC, the CHI and addresses were added to the dataset. CHI was used to create a unique identifier for linkage of weight management data with education data.

The Information Officer from Angus Council reported that the extraction and collection of data, writing the macro and testing the spread were conducted over a two-month period. In total seven to eight days were needed to initiate the transfer of extracted data. There were a number of steps involved from receiving the POST identifiers for each child of interest to getting the data extract. Deterministic record linkage was used to match education data of POST referrals. The steps were as follows:

1. Vision search report was used to match pupils against the POST identifiers aligning spelling differences in children's names.
2. The report was appended with SEEMiS identifiers and additional comments with date of leaving the school within the Council area were added.
3. Extract reports in Vision and Scottish candidate number (SCN) Extract were created. These reports extracted personal details, 5-14 attainment, the attendance data, exclusions data and SCN for match to the SQA file.
4. A copy of the post appeal SQA results file for each year from and including 2007 was obtained (2007 was the year Secondary schools started using SEEMiS in Angus).
5. A yearly folder structure for the extracted files was set up.
6. A macro was written because there were a number of data per years to filter, clean and process.

7. An extract of data from one time point of measurements was provided to me (via HIC safe haven) to confirm the correctness of the extracted data items and clarification on structure of requested data.
8. Data for each available entry year was extracted using the macro.

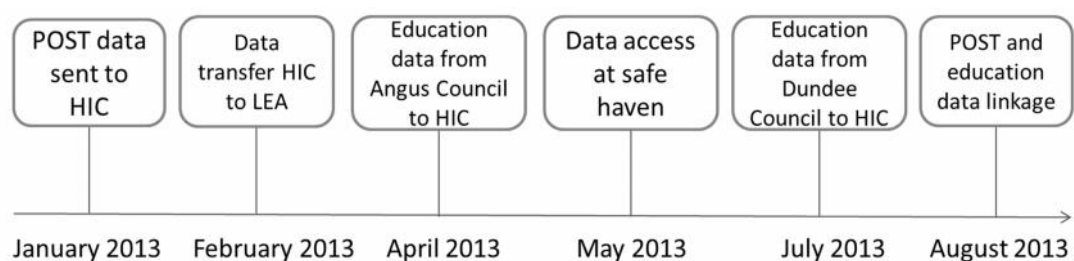
The macro written by the Information Officer at Angus Council was then forwarded to his colleagues at Dundee Council to facilitate their data extraction process. Therefore, the data files from both LEA followed the same structure. However, some data items were missing in the Dundee Council dataset which were obtained after contacting the responsible Information Officer.

**Data transfer and linkage.** The prepared NHS POST database for this research project contained weight management data without Community Health Index (CHI) numbers and addresses/postcodes. After this database was sent to HIC, missing identifiers required for matching of health and education data were added by HIC who then extracted the personal identifiers (name, date of birth, address) and transferred them to the Local Education Authorities (LEA). The data extract containing POST data was sent to HIC by the POST team leader via email within the secure NHS Tayside file transfer system. The Information Officers at the LEA identified the pupils of interest in their database (SEEMiS), extracted the data and transferred them back to HIC. Data transfer methods to and from LEA differed for each Council. Data sharing with Angus Council was possible via a web-based secure file transfer system (located at [www.transfer.angus.gov.uk](http://www.transfer.angus.gov.uk)) and for Dundee City Council a secure access portion of a secure FTP (File Transfer Protocol) server which resides within the council were used.

A Data Analyst at HIC added a unique identifier (PROCHI) to both records, anonymised the data and made them available for access in the safe haven facilities. The unique identifier (PROCHI) consisted of three letters referring to the project number and seven numbers which were randomly generated and cannot be related to the original CHI number. HIC retained a mapping table which allows them to reverse this anonymisation if required.

This entire data transfer/data sharing process started at the end of January 2013 and was completed in August 2013. Figure 4.4 shows the timeline of data sharing. Email correspondence with the Information Officer from Angus Council confirmed that the final output file for transfer to HIC was created within 15 minutes “provided all extracts are located in the correct folder.”

Datasets from both sources were available at the safe haven as separate excel files. Additional demographic data (e.g. gender) were provided by HIC also in form of an excel file. After importing the datasets to the statistic software Stata 11 (StataCorp, 2009). I performed the linkage of POST and education records based on the unique identifier (PROCHI) which was generated by HIC.



**Figure 4.4: Timeline of data sharing.**

POST: Paediatric Overweight Service Tayside. HIC: Health Informatics Centre, LEA: Local Education Authorities

### Number of missing participant observations

There were four main reasons for missing or exclusion of participant observations:

- exclusion of participants from the POST database due to not meeting the age criterion
- non-attendance of publicly funded schools in the Tayside area
- missing data entries in the education database SEEMiS
- missing suitable educational attainment data

**Exclusion from POST.** The roll-out of POST started in the NHS Tayside area of Perth and Kinross Council in May 2009. In September 2009 POST was available for families in the NHS Tayside area of Dundee Council and Angus Council. For this pilot study the POST database contained participant data updated until June 2012.

The total number of participants in the POST database was 526, including children aged 2-15 years. Considering the two Tayside areas separately where education data were accessible, 203 children were from Dundee and 159 children from Angus.

Since primary school education is mandatory for children from the age of 5 years in Scotland, children younger than 5 years were excluded from the POST database for the purpose of this study. In total 20 children were excluded; 12 from Dundee City and eight from Angus. Therefore the maximum possible number of POST participant data matched with education data is a sample size of 342, with 191 children from Dundee and 151 children from Angus (Table 4.3).

**Mismatch between POST and LEA databases.** Information Officers from participating LEA reported that children who were referred to POST were identified in SEEMiS initially based on pupils' forename and date of birth. From the returned results, the other details (surname, address, post code) were verified, against the index, for a positive match. The matching success rate of POST participants within SEEMiS at Angus Council was 97% with 147 out of 151 possible children successfully identified. All children who were referred to POST and live in Dundee were identified in SEEMiS at Dundee City Council (Table 4.3).

Between 2009 and 2012 on average 50,138 pupils attended schools in Tayside of which 17,374 pupils attended schools in Dundee, and 15,298 in Angus (The Scottish Government, 2013b). Therefore, of all pupils in Tayside 1.5% were referred to POST and thus their education data potentially available for data-linkage and data analysis. However, only children who attended a state school will have education data recorded in the local education authority. A lack of matching of POST data and education data might occur when children attended a public or private school, a school outside the local education authority area or when the child was home schooled.

**Missing data entry in SEEMiS.** Separate files containing anonymous data from the POST database and SEEMiS from the LEAs were available at the safe haven for data analysis. After importing the files into the statistic software STATA 11 the separate

files were merged based on an identifier available in both POST and LEA data files. The identifier was the anonymised children's CHI number generated by HIC and renamed as PROCHI.

POST and education data of 338 children were successfully matched but for 14 children (N=2 from Angus Council, N = 12 from Dundee City Council) no education data entry was provided. The reasons for this could not be determined. The total number of participant observation with some or all POST and education variables was 324 (Table 4.3).

**Exclusion due to unsuitable education data.** Some successfully matched participant observations could not be used for the analyses for the following two reasons and were therefore excluded; (i) some children were still in nursery hence no educational attainment data were available and (ii) for some children only attainment data assessed within CfE were available. Since the 5-14 curriculum and CfE differ considerably and are not comparable in their approach of teaching and assessment I included only 5-14 attainment measures to ensure comparability between children. Data of nine children were excluded due to availability of CfE attainment data only. Twenty-three children were still at nursery at the time of attainment assessment prior to POST referral and were not included in the study population. Overall, the linked dataset used for analyses contained data of 292 children of which 136 were from Angus and 156 from Dundee (Table 4.3).

**Table 4.3: Summary of the number of available participant data by local education authority.**

	<b>Eligible POST participants</b>	<b>Entry in LEA school</b>	<b>Match + SEEMiS entry</b>	<b>Pre- CfE</b>	<b>Enrollment in P1-S3</b>
Angus	N = 151	N = 147	N = 145	N= 142	N= 136
Dundee	N = 191	N = 191	N = 179	N = 173	N = 156
<b>TOTAL</b>	<b>N = 342</b>	<b>N = 338</b>	<b>N = 324</b>	<b>N = 315</b>	<b>N = 292</b>

### **Accessibility of data for research**

Generally, the available administrative data from both sources were of use for research although they were not recorded for this purpose. The majority of the data obtained from the NHS POST database were measured objectively whereas the reliability of administrative attainment data might be limited. All education data were teacher recorded and in particular assessment of 5-14 attainment is not standardised and thus might vary between teachers and is prone to bias due to subjectivity. The 5-14 attainment levels were commonly assessed in an ordinal fashion with different levels obtainable at different stages of schooling. The lack of a consistent attainment assessment scale within each schooling stage required conversion of educational attainment data to a meaningful binary attainment data (meeting or not meeting expectations) to ease interpretation of findings.

**Availability of response and predictor variables.** Out of 292 eligible children who were referred to POST and attended at least P1, only 38 children had educational attainment data in at least one school subject assessed before and after POST referral. This represents a reduction of the initial dataset by 87%. Table 4.4 summarises the number of children with available pre/post-treatment reading, writing, or mathematics attainment data in the three different programme completion groups (not opted-in, not completed, completed) by LEA. Pre and post-treatment reading attainment was available for 28 children, writing attainment for 25 children and mathematics attainment for 13 children. Complete pre and post-treatment attainment data for all three subjects were available for seven children only. Therefore, for the majority of suitable participant data only one or two subjects were assessed while for the remaining ones no data were available. Under the assumption that missingness is random, missing attainment data can be estimated using multiple imputation models (for justification of ‘missing at random’ and description of the imputation method see 4.2.6). In relation to the study population of  $N = 38$ , the proportion of missing mathematics attainment data was too high (66%) for multiple imputation. In general, the number of available mathematics attainment data was too low to perform regression analysis and hence I could not determine the effect of childhood weight management on participants’ mathematics attainment. Data for reading and writing

attainment were sufficient in number for regression analyses and, despite relatively high proportions of missing data (26% for reading and 34% for writing attainment relative to N = 38) data were multiply imputed and used for further analyses.

A considerable number of children had missing data within predictor variables. Table 4.5 lists the data items with missing values and summarises the proportion of missingness. Values were missing for pre and post-treatment quality of life, BMI and BMI-SDS, and pre-treatment attainment progress. Pre-treatment assessment of child's quality of life was missing for 12 out of 38 children and for even fewer children, quality of life was assessed after the treatment was completed which resulted in missing data for 29 children. The reason for missing child-assessed quality of life values is simply due to failed assessment by POST practitioners. Even for children who completed the programme quality of life was not assessed for most children. In contrast, pre-treatment BMI and BMI-SDS is only missing for children who did not opt in to POST and where no body weight status data were available on the referral letter. Out of 38 children, 13 had missing post-treatment BMI and BMI-SDS values of which seven children did not opt in and six children did not complete the programme. Therefore, assessment of body weight and height was not possible at post-treatment for these children and BMI/BMI-SDS could not be calculated. Of the 13 children with assessed mathematic attainment for one child, pre-treatment progress in mathematics was not available. Out of 25 children with assessed writing attainment, pre-treatment writing progress was missing for five children and four out of 28 children had missing pre-treatment reading progress data. Missingness of pre-treatment progress is due to unreported attainment two years prior to the POST referral.

**Table 4.4: Number of children with assessed pre/post-treatment educational attainment.**

	<b>Reading</b> (N = 28)	<b>Writing</b> (N = 25)	<b>Mathematics</b> (N= 13)
<b>Angus Council</b>			
No-opt in	3	3	0
Non-completers	5	2	1
Completers	8	7	3
TOTAL	16	12	4
<b>Dundee Council</b>			
No-opt in	2	2	0
Non-completers	3	4	4
Completers	7	7	5
TOTAL	12	13	9



**Table 4.5: Proportion of missing values for predictor variables**

Variable	Proportion
Pre-treatment BMI [kg/m <sup>2</sup> ]	1 (2.6%)
Pre-treatment BMI-SDS	1 (2.6%)
Post-treatment BMI [kg/m <sup>2</sup> ]	13 (34.2%)
Post-treatment BMI-SDS	13 (34.2%)
BMIchange [kg/m <sup>2</sup> ]	1 (2.6%)
BMI-SDS change	2 (5.3%)
Pre-treatment PedsQL	
Physical health	12 (31.6%)
Psychosocial health	12 (31.6%)
Post-treatment PedsQL	
Physical health	29 (76.3%)
Psychosocial health	29 (76.3%)
Pre-treatment attainment expectations	
Reading	10 (26.3%)
Writing	13 (34.2%)
Mathematics	25 (65.8%)
Pre-treatment progress	
Reading	14 (63.2%)
Writing	18 (47.4%)
Mathematics	26 (68.4%)

**Remote access.** Accessing the data remotely for analysis was unproblematic after familiarising with the procedures and solving some technical issues (e.g. safe haven access using Windows 8, resetting the password). Output files containing data management and analysis syntaxes and analysis results were approved within two working days and provided via email.

**Data format.** HIC provided all data sets in excel files which could be easily imported into Stata 11 for further analysis (StataCorp, 2009). Data items and order of variables differed between LEA. Thus the datasets had to be modified to allow merging of the two LEA and POST data sets.

### **4.3.2. Effectiveness of weight management on post-treatment attainment**

The results of the effect of weight management on participants' educational attainment are presented in three parts:

1. Description of participant characteristics at baseline
2. Within completion group attainment differences pre/post intervention
3. Differences in post-treatment educational attainment between completion groups and as function of number of attended POST sessions

Findings are presented for complete case analysis and analysis with imputed data.

#### **Description of participant characteristics at baseline**

Since this study is a non-randomised controlled intervention trial it is important to give a comprehensive overview of baseline characteristics between comparison groups. Table 4.9 provides an overview of characteristics of all available baseline variables for the total study population and by comparison group. Significance of differences in characteristics between comparison groups can be found in the last column of Table 4.8.

Data of 38 children were available to investigate the effect of a primary care weight management programme on educational attainment. Nineteen children each were from Angus and from Dundee. Out of 38 children, seven children were referred but did not opt in to POST, 12 children opted-in but did not complete the treatment programme, and 19 children completed POST (i.e. attended 75% of the sessions). The mean number of attended sessions in the non-completer group was three sessions and children who completed the programme attended on average seven sessions.

The mean referral date was 18 December 2009 with the earliest referral on 25 June 2009 and the latest referral included in this study cohort was 2 June 2010.

There was a higher proportion of girls (total sample 71%) than boys (total sample 29%) across all comparison groups. The mean referral age was 10.9 (2.0) years with an age range from 7.0 years to 14.4 years. Only three children were younger than 8 years and were therefore allocated to the SCOTTLite intervention programme of POST; all completed the intervention. English was the first language for all children and the vast majority of children were of White-Scottish ethnic background (89%), had no looked after status (95%) and were free of diagnosed disabilities (95%). Almost half of the children (47%) were classified as being in the lowest quintile of the Scottish Index of Multiple Deprivation and three children (8%) were registered to receive free school meals. The mean BMI was 29.8 (4.5) kg/m<sup>2</sup> and children had on average a BMI-SDS of 3.0 (0.5).

Participant number varied for attainment variables; pre and post treatment reading attainment was assessed for 28 children, writing attainment for 25 children and mathematics attainment for 13 children. Some children had only one subject assessed while for other children two or even all three subject attainment measures were available. For children with only one or two subjects assessed, missing values for the non-assessed subject(s) were estimated using multiple imputation (MI) methods. Therefore, the sample size after multiple imputation was N = 38 for reading and writing. Given that for more than 50% of the children mathematics attainment values were missing (66%), missing values were not estimated and thus only complete case findings were available.

Pre-treatment education data were all from the school year 2008/2009 and post-treatment education data were from the following school year 2009/2010. Since time of attainment assessment and referral to POST differed between children, the time between baseline assessment and referral and the time between referral and post-intervention attainment assessment was not consistent for all children and across subject assessment. On average, reading attainment was assessed 13.3 (7.8) months before referral, writing attainment 13.8 (6.8) months before referral, and mathematics attainment 13.7 (7.5) months before referral.

The study population included children from the schooling stage of primary 2 (P2) up to secondary 1 (S1). Fourteen children attended P2-P4 whereas 17 children attended P5-P7 and seven children were in S1. Five children required an Individual Education Plan but none of the included children needed a Coordinated Support Plan. The frequency and proportion of children meeting attainment expectations in the three subjects at baseline are listed in Table 4.10. Based on complete case analysis, the number of children who met attainment expectations at baseline was 20 (71%), 16 (64%), and 11 (85%) for reading, writing and mathematics, respectively. After multiple imputation of missing values for reading and writing, 12 children (32%) met reading expectations and seven children (18%) met writing expectations. In terms of attainment progress, the proportion of children who progressed by one attainment level from the school year 2007/2008 to 2008/2009 was 34% in reading, 18% in writing and 50% in mathematics.

The median number of missed school days was 14 days (range 0-47 days) of which 10 days (0-35 days) were authorised absences and one day was an unauthorised absence (range 0-40 days). The majority of children were not excluded from school; two children were excluded due to misbehaviour.

Between-group comparison of baseline characteristics indicated no statistically significant difference for all but two assessed variables. As expected (and intended) due to the study design, there was a significant difference of number of attended POST session ( $F = 103.26$ ,  $df = 2$ ,  $P < 0.01$ ). Groups also differed significantly in the proportion of children entitled to receive free school meal ( $P = 0.03$ ). Children who received free school meals were all in the non-completer group and none of the children in the other two groups were registered to receive free school meals.

### **Within completion group differences in educational attainment over time**

Table 4.9 lists absolute numbers and proportions of children who met attainment expectations before and after the intervention for each comparison group. Overall, within each group the proportion of children meeting reading and writing attainment expectations increased over time. In terms of changes in mathematics attainment, for children who completed the programme the proportion of children that met the

attainment expectations increased over time. However, there was no change in the proportion of children who did not complete the intervention in relation to meeting mathematic attainment expectations. There were no mathematics attainment data available for children who did not opt-in to the programme.

Using complete case data, within group comparison of attainment expectations before and after the intervention suggested no significant difference for reading, writing and mathematics. However, findings of within group comparison using imputed data indicated some significant differences of the proportion of children meeting reading and writing attainment expectations over time. For reading attainment expectations, McNemar's exact test indicated a significant increase by 67% ( $P < 0.01$ ) and 42% ( $P < 0.01$ ) in the non-completer group and completer group, respectively. There was no evidence of a statistically significant increase over time in the proportion of children meeting reading expectations for those who failed opting in to the intervention. Similarly, there was a significant increase of the number of children meeting writing expectations over time by 67% ( $P < 0.01$ ) and 52% ( $P < 0.05$ ) in the non-completer group and completer group, respectively. Since no child, who did not opt-in to the intervention, met writing expectations at baseline the significance of the difference over time could not be calculated using McNemar's exact test.

### **Differences in post-treatment educational attainment between completion groups and as function of number of attended POST sessions**

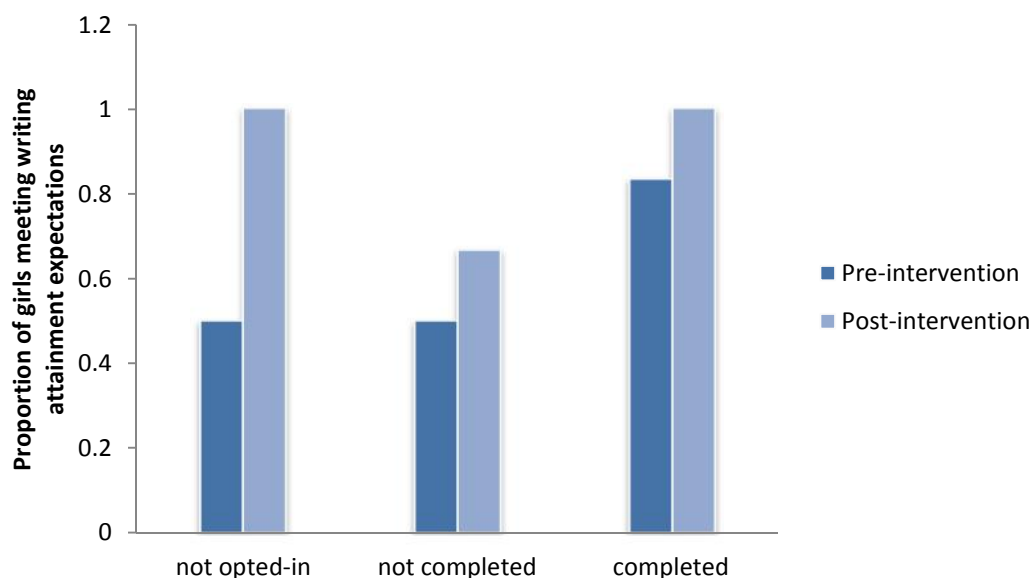
Using complete cases, 86% of the children met reading expectations, 80% met writing expectations, and 92% met mathematics expectations. When using the imputed dataset, 84% of the children met the reading expectations and 73% met the writing expectations at post-treatment.

Based on complete cases, the median time difference between referral to POST and post-treatment reading assessment was 3.1 months (range 0.3-11.2 months), between POST and mathematics assessment 5.9 months (range 0.2-11.0 months), and writing attainment was assessed on average after 5.1 (3.1) months after referral to POST. The time difference between referral to POST and attainment awarded varied non-significantly between children in the three comparison groups in

reading ( $\chi^2 = 1.90$ ,  $P = 0.39$ ), writing ( $F = 1.11$ ,  $df = 2$ ,  $P = 0.35$ ) and mathematics ( $z = -0.15$ ,  $P = 0.88$ ).

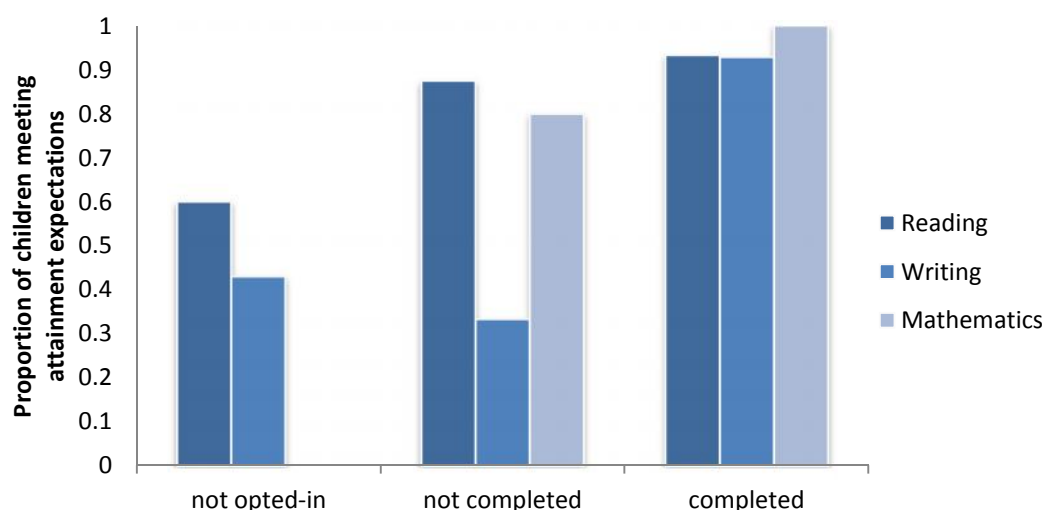
Using Fisher's exact test, there was no gender difference in post-treatment reading ( $P = 0.39$ ) and mathematics attainment ( $P = 0.15$ ). However, Fisher's exact test suggested a significant difference in post-treatment writing attainment between boys and girls. Proportionally more girls met writing expectations compared to boys ( $P = 0.04$ ). There was no gender difference in writing expectation before the intervention ( $P = 0.23$ ) suggesting a potential benefit of the intervention for girls and/or more attainment progress over time in girls compared to boys. Supporting the attainment progress hypothesis, across all comparison groups, more girls met writing expectations at post-treatment ( $N = 18$ ) compared to pre-treatment ( $N = 14$ ). In relation to a potential effect of the intervention on girls' writing attainment, compared to group 1 and 2, twice as many girls in the completion group met expectations at post-treatment compared to pre-treatment (Figure 4.5). However, there was no statistically significant difference between groups in the proportion of girls meeting writing expectations ( $P = 0.51$ ).

There were also no statistically significant differences in post-treatment attainment expectations between groups by ethnicity, SIMD, looked after status, school absenteeism, school exclusion, BMI-SDS and BMI.



**Figure 4.5: Proportion of girls meeting writing attainment expectations pre and post intervention by comparison groups**

Figure 4.6 shows the proportion of children meeting reading, writing and mathematics attainment in the three comparison groups based on complete cases. Fisher's exact test indicated no significant difference between the three comparison groups and reading attainment expectations ( $P = 0.19$ ), writing expectation ( $P = 0.10$ ), and mathematics expectations ( $P = 0.39$ ). Findings of logistic regression analyses are summarised in Table 4.7 displaying unadjusted odd ratios and confidence intervals for differences in meeting reading and writing expectation between comparison groups with 'not opted-in' as reference group. Due to the low number of children with post-treatment mathematics attainment observations, it was not possible to obtain results from logistic regression analysis.



**Figure 4.6: Proportion of children meeting attainment expectations by comparison groups.**

Findings of the complete case analysis suggest that children who completed the weight management programme POST are nine times more likely to meet reading attainment expectations relative to the stage of schooling and children who did not complete the intervention are five times more likely to meet reading expectations compared to children who did not opt in to POST. In terms of meeting writing expectations, compared to children who failed to opt in to POST, children who completed the intervention were four times more likely to meet attainment expectations whereas not completing the programme reduced the odds of meeting attainment expectations by 56%. Results for both reading and writing expectations were not statistically significant at a 5% level (Table 4.6). Wide confidence intervals indicate poor strength (imprecision) of the findings, which are most likely attributable to the low sample size.

Findings from combined logistic regressions of multiply imputed data sets (M=35) yielded similar results as the complete case analysis. Odds ratios and confidence intervals were slightly lower and narrower, respectively, but there was also no evidence of a statistically significant effect of participation in POST on reading and writing attainment (Table 4.6).



**Table 4.6: Odd ratios of meeting attainment expectations by completion group and in relation to the number of sessions attended.**

	Meeting Reading Expectations			Meeting Writing Expectations		
	OR	95% CI	<i>p</i>	OR	95% CI	<i>p</i>
<b>Complete Cases</b>						
<i>Completion</i>						
(ref = not opted-in)						
Non-completers	4.67	0.30 – 73.38	0.27	0.44	0.03 - 6.70	0.56
Completers	9.33	0.62 – 139.57	0.12	4.33	0.21 - 90.85	0.36
<i>Number of sessions attended</i>						
Total sample	1.29	0.89 – 1.86	0.18	1.44	0.99 - 2.00	0.05
SCOTT	1.27	0.89 – 1.82	0.19	1.42	0.98 - 2.06	0.06
<b>Imputed data set</b>						
<i>Completion</i>						
(ref = not opted-in)						
Non-completers	2.50	0.91 – 32.97	0.48	0.86	0.09 – 7.92	0.89
Completers	7.46	0.54 – 103.50	0.18	3.58	0.30 – 42.17	0.31
<i>Number of sessions attended</i>						
Total sample	1.28	0.91 – 1.82	0.15	1.28	0.45 – 1.78	0.14
SCOTT	1.28	0.92 – 1.80	0.15	1.26	0.92 – 1.74	0.15

Note: complete cases – Reading expectations N = 28, writing expectations N = 25, imputed data – reading and writing expectations N = 38

To determine whether the number of attended POST sessions can predict whether a child who was referred to the weight management programme met reading or writing expectations, another set of logistic regression analyses with the continuous variable ‘number of sessions attended’ were performed. Since POST offers different intervention schemes depending on the age of the child, I analysed both the total sample and the sample with children who were allocated to SCOTT (Table 4.6).

Based on complete case analysis, results suggest no significant effect of participation in weight management on meeting reading attainment expectations. However, findings on the effect of number of sessions attended on writing expectations approached significance indicating that with each attended session an

overweight or obese child is 1.4 times more likely to meet schooling stage adequate writing expectations (total sample  $P = 0.05$ , SCOTT  $P = 0.06$ ). However, this result does not account for other potential covariates. Since a gender difference in post-treatment writing attainment was detected, gender was entered into the analysis as covariate with boys as reference category. After controlling for gender the odds of meeting writing expectations remained 1.4 for each attended POST session. However, this finding was no longer significant at a 5% level for both the total sample and SCOTT (Table 4.7).

Findings from the analysis of the combined multiply imputed data suggested no evidence of an association between number of attended sessions and meeting attainment expectations in reading and writing again for both the total sample and SCOTT (Table 4.6).

**Table 4.7: Odd ratios and confidence intervals of the effect of number of POST sessions attended on meeting writing attainment expectations adjusted for gender (reference = boys).**

	<b>Model 1</b>	<b>Model 2</b>
Total sample	1.37 (0.91-2.06)	-
SCOTT	-	1.36 (0.90-2.04)
Girls	10.33 (0.83 – 129.19) <sup>a</sup>	9.89 (0.79 – 123.21) <sup>b</sup>
Model significance	Likelihood ratio $\chi^2 = 7.84$ , $p = 0.02$ ,	Likelihood ratio $\chi^2 = 7.52$ , $p = 0.02$ ,
Model fit	Goodness-of-fit $p = 0.11$	Goodness-of- fit $p = 0.12$

<sup>a</sup>  $P = 0.07$ , <sup>b</sup>  $P = 0.08$

**Table 4.8: Socio-demographic, treatment-related and school-related participant characteristics at baseline**

		Comparison groups				Group differences
		Total	Not opted-in	Not completed	Completed	
		(N = 38)	(N = 7)	(N = 12)	(N = 19)	
Socio-demographic variables						
Gender						Fisher's exact test
	Boys	11 (29%)	3 (43%)	3 (25%)	5 (26%)	P = 0.72
	Girls	27 (71%)	4 (57%)	9 (75%)	14 (74%)	
Age at referral		10.9 (2.0)	11.7 (2.2)	11.4 (1.6)	10.3 (2.1)	F=1.74, df = 2, P = 0.19
Ethnicity						Fisher's exact test
	White-Scottish	34 (89%)	7 (100%)	10 (83%)	17 (89%)	P = 0.65
	Other	4 (11%)	0 (0%)	2 (17%)	2 (11%)	
Area						Fisher's exact test
	Angus	19 (50%)	3 (42%)	6 (50%)	10 (53%)	P = 1.0
	Dundee	19 (50%)	4 (57%)	6 (50%)	9 (47%)	
SIMD quintile						Fisher's exact test
	1	18 (47%)	4 (57%)	6 (50%)	8 (42%)	P = 0.72
	2	7 (18%)	1 (14%)	4 (33%)	2 (11%)	
	3	2 (5%)	0 (0%)	0 (0%)	2 (11%)	
	4	8 (21%)	1 (14%)	2 (17%)	5 (26%)	
	5	3 (8%)	1 (14%)	0 (0%)	2 (11%)	

		Comparison groups				Group differences
		Total (N = 38)	Not opted-in (N = 7)	Not completed (N = 12)	Completed (N = 19)	
<hr/>						
Free school meal entitlement						Fisher's exact test
	Yes	3 (8%)	0 (0%)	3 (25%)	0 (0%)	<b>P = 0.03</b>
	No	35 (92%)	7 (100%)	9 (75%)	19 (100%)	
Looked after						Fisher's exact test
	Yes	2 (5%)	0 (0%)	1 (8%)	1 (5%)	P = 0.76
	No	36 (95%)	7 (100%)	11 (92%)	18 (95%)	
Disability						Fisher's exact test
	Yes	2 (5%)	0 (0%)	2 (17%)	0 (0%)	P = 0.12
	No	36 (95%)	7 (100%)	10 (83%)	19 (100%)	
<b>Treatment related variables</b>						
POST programme						Fisher's exact
	SCOTTLite	3 (8%)	0 (0%)	0 (0%)	3 (16%)	P = 0.28
	SCOTT	35 (92%)	7 (100%)	12 (100%)	16 (84%)	
BMI-SDS (N = 37)		3.00 (0.46)	2.92 (0.39)	3.02 (0.57)	3.02 (0.41)	F = 0.1, df = 2, P = 0.89
BMI [kg/m <sup>2</sup> ] (N = 37)		29.79 (4.47)	29.60 (4.39)	30.77 (4.74)	29.23 (4.46)	F = 0.4, df = 2, P = 0.65
Sessions attended		4.5 (3.0)	0	3.3 (1.2)	7.1 (1.2)	F = 103.26, df 2, P < 0.01

		Comparison groups				Group differences
		Total (N = 38)	Not opted-in (N = 7)	Not completed (N = 12)	Completed (N = 19)	
Schooling related variables						
School stage						Fisher's exact test
	P2-P4	14 (76%)	2 (29%)	2(8%)	10 (52%)	P = 0.54
	P5-P7	17 (24%)	2 (29%)	8 (67%)	7 (37%)	
	S1	7	3 (43%)	2 (8%)	2 (11%)	
Individual Education Plan						Fisher's exact test
	Yes	5 (13%)	2 (29%)	2 (17%)	1 (5%)	P = 0.18
	No	33 (87%)	5 (71%)	10 (83%)	18 (95%)	
School absenteeism [days/year]						Kruskal-Wallis Test
	Total	14.0 (0-47.0)	20.5 (1.5-44.0)	14.0 (0 -47.0)	12.5 (2.0 – 42.0)	P = 0.33
	Authorised	9.75 (0-34.5)	9.0 (1.5-28.0)	9.5 (0 – 34.5)	10.5 (1.5-25.0)	P = 0.73
	Unauthorised	1.0 (0-39.5)	8.0 (0 – 10.0)	0.8 (0-39.5)	0 (0 – 25.0)	P = 0.07
Exclusion						Fisher's exact test
	Yes	2 (5%)	2 (29%)	0 (0%)	0 (0%)	<b>P = 0.03</b>
	No	36 (95%)	5 (71%)	12 (100%)	19 (100%)	
Reading attainment progress (N = 24)						Fisher's exact test
	No progress	11 (46%)	4 (80%)	3 (43%)	4 (33%)	P = 0.27
	Progress by 1 level	13 (54%)	1 (20%)	4 (57%)	8 (67%)	

		Total (N = 38)	Comparison groups			Group differences
			Not opted-in (N = 7)	Not completed (N = 12)	Completed (N = 19)	
Writing attainment progress (N = 20)		13 (65%)	2 (67%)	4 (67%)	7 (64%)	Fisher's exact test P = 1.0
	No progress	7 (45%)	1 (33%)	2 (33%)	6 (36%)	
	Progress by 1 level					
Math attainment progress (N = 12)						Fisher's exact test P = 0.24
	No progress	6 (50%)	-	4 (80%)	2 (29%)	
	Progress by 1 level	6 (50%)	-	1 (20%)	5 (71%)	
Attainment award-referral lag time [month]						
	Reading (N = 28)	13.3 (7.8%)	17.9 (8.7%)	14.6 (7.7%)	11.2 (7.4%)	F=1.56, df 2, P = 0.23
	Writing (N = 25)	13.8 (6.8%)	13.3 (7.6%)	14.9 (8.1%)	13.4 (6.4%)	F=0.12, df 2, P = 0.89
	Mathematics (N = 13)	13.7 (7.5%)	-	17.1 (7.0%)	11.6 (7.5%)	t=1.32, df 11, P = 0.89

**Table 4.9: Pre/post intervention comparison of the proportion of children meeting attainment expectation by completion group**

	N total	Not opted in				Non-completed				Completed			
		N	pre	post	post-pre	N	Pre	post	post-pre	N	pre	post	post-pre
Complete Cases													
Reading	28	5	2 (40%)	3 (60%)	+1 (20%)	8	5 (63%)	7 (88%)	+2 (25%)	15	13 (87%)	14 (93%)	+1 (6%)
Writing	25	4	2 (50%)	3 (75%)	+1 (25%)	7	3 (43%)	4 (57%)	+1 (14%)	14	11 (79%)	13 (93%)	+2 (14%)
Mathematics	13	0	-	-	-	5	4 (80%)	4 (80%)	0 (0%)	8	7 (88%)	8 (100%)	+1 (12%)
Imputed cases*													
Reading	38	7	1 (14%)	4 (57%)	+3 (43%)	12	1 (8%)	9 (75%)	+8 (67%)	19	10 (85%)	18 (95%)	+8 (42%)
Writing	38	7	0 (0%)	5 (71%)	+5 (71%)	12	1 (8%)	9 (75%)	+8 (67%)	19	6 (32%)	16 (84%)	+10 (52%)

\*Note: within group comparison of binary data not possible with the multiply imputed dataset. Therefore only one imputed dataset was used (m = 15) to estimate the post-intervention attainment and within group difference

## **4.4. Discussion**

### **4.4.1. Feasibility of linking weight management and education data in Scotland**

Getting access to sensitive data needed to perform a data-linkage, required careful legal and ethical consideration by all involved parties. For this study, approvals from NHS Tayside Research and Development Office (R&D), local education authorities (LEA) and the University of Edinburgh had to be obtained. Involvement of a secure and safe data transfer and data hosting system (HIC) was a crucial step to allow for data sharing in alliance with the Data Protection Act 1998. However, data from one LEA could not be obtained without direct parental consent for data access. Problems with getting permission to access education data for research locally might be overcome through obtaining permission on the national level using approved data linkage systems. Since education data are collected as part of the annual Pupil Census, entered into SEEMiS by all LEA and centrally accessed by the Scottish Government to produce Census Summary Statistics for all LEA, approval to access education data could be obtained on a national level through the Privacy Advisory Committee (PAC). Previous research has shown that access to education data from all LEA across Scotland is feasible (Pell et al., 2012).

HIC staff members confirmed no technical issues during the data transfer stage. However, obtaining approvals and extraction of specific data items from all data sources was laborious and time consuming. Overall, obtaining approvals and eventually getting access to the data at the safe haven was a long process; it took almost two years (November 2011 – August 2013). The reasons for delay of data access might be that this data-sharing exercise was new to staff members at the NHS Tayside R&D, LEA and HIC. Processes of data-sharing were unknown to all involved parties and Standard Operating Procedures had to be consulted involving Legal Departments. Another factor of delay might have been the change in staff at Dundee Council which in turn required appointment of another Information Officer who had to familiarise herself with this data linkage project.



A delay in data access and extraction was also noted by a recent cross-sectorial data linkage study matching maternity records with education data (Pell et al., 2012). Although researchers accessed health and education data centrally on a national level using the services of the Information Service Division (ISD) of the Scottish Government, data access was delayed by six months (Pell et al., 2012). Therefore, obtaining approvals for data linkage appears to be the part of the data linkage exercise that costs most time. Given the increasing interest in data linkage studies and awareness of their feasibility and potential, approval processes may become routine and subsequently faster data access for research is possible.

Of all eligible children who were referred to POST, for 99%, weight management data were successfully linked with education data. Matching success rates of over 90% are common when using established matching methods. However, rates of successful matching might be reduced the more records are linked and the larger the records in terms of participants. For example, Pell et al. (2012) reported a matching success of over 90% for the linkage of three education and one health records resulting in a sample size of 803,275 children (Pell et al., 2012). Wilson et al. (2013) managed to receive linked data of 97.4% of the initial study population (N = 4346) when combining two research data sets with two administrative health data sets (Wilson et al., 2013).

Remote access, merging, managing and analysis of data proved to be feasible with only minor technical issues which could be solved immediately by the HIC safe haven support team. However, the quality of both POST and education data was potentially insufficient to answer the research question: whether participation in a primary care weight management programme can influence pupils' educational attainment. The number of children with available attainment data in reading, writing or mathematics before and after the treatment was very low; only 12% of the successfully matched individual data were suitable for analysis. Reasons for the low number of suitable participant data were related to the timing of POST implementation and change of the national school curriculum. POST started the roll out of the intervention programme in Dundee and Angus in 2009, after the

government initiative for *Child Healthy Weight Interventions* (HEAT-H3) was created. On the other hand, the change of the school curriculum from the 5-14 guidelines to CfE became effective with the school year 2010/2011. Since teaching approaches and attainment assessment of the two curricula are not comparable, only 5-14 attainment data were selected for analysis. This resulted in exclusion of all children who were referred to POST in 2011 and 2012 because those children were already taught according to CfE. Additionally, children referred to POST before CfE implementation were not suitable for inclusion when post-treatment attainment assessment was done using CfE guidelines. Therefore, only a low number of children with 5-14 attainment assessment before and after referral to POST remained.

Furthermore, a number of potentially relevant confounding and mediating variables were not available in the linked data set. Since in this study children were non-randomly classified into comparison groups, effect of the intervention could be due to several unobserved and thus uncontrolled factors. Potential mechanisms for how a weight management programme can benefit educational attainment (see Chapter 2.5) indicated an important role of physical activity, diet and sedentary behaviour. Factors such as child's general health, neuro-cognitive abilities and psychosocial functioning, may also play a role in the pathway of beneficial effects of weight management on educational attainment in overweight and obese children. Education related factors such as class size, teachers' attitude, child's attitude towards school, and weight-related experiences in school (e.g. peer bullying/teasing) might be important factors to explain changes in educational attainment after participation in a weight management programme when using a non-randomised controlled study design. POST practitioners attempted to collect quality of life data (e.g., physical and psychosocial health) but this was done only by a few practitioners so that the available data set showed a high proportion of missing values for assessment of quality of life which could then not be used for analysis.

#### **4.4.2. Effectiveness of child weight management on participants' educational attainment**

Data from 38 children were available to assess the effectiveness of a child weight management intervention on educational attainment of Scottish overweight and obese children. This study was a non-randomised controlled intervention employing a secondary analysis of administrative child weight management and education data. Between-group comparison of experimental groups at baseline suggested good comparability since there was no statistically significant difference between groups for all but one (school exclusion) variables.

Findings from the analysis of multiply imputed data indicated a significant increase in the number of children who met reading and writing attainment expectation from before to after intervention participation for both non-completers and completers. There was a higher increase in the non-completer group compared to the completer group while no significant changes were detected or assessable in the 'not opted in' group. Complete case analysis also showed an increase in the number of children meeting attainment expectation over time but the change was not statistically significant. Mathematics attainment over time seemed to be unaffected by the intervention. Analysis findings suggested that there is some evidence of a gender difference in post-treatment writing attainment with more girls meeting writing expectations than boys. The significant difference might be due to a stronger attainment progress over time in girls compared to boys rather than an intervention effect given that between-group comparison indicated no statistically significant difference in attainment between boys and girls. Indeed, data from the latest Scottish Survey of Literacy and Numeracy confirm a widening achievement gap in writing attainment with age between boys and girls (The Scottish Government, 2013d).

Using both complete cases and imputed data sets, there was no statistically significant evidence of a beneficial effect of a primary care child weight management programme on reading, writing and mathematics attainment in overweight and obese children. However, when using number of attended POST sessions instead of intervention completion categories as predictor of post-treatment attainment, findings suggested that with each attended session children are 1.4 times more likely to meet

writing attainment expectations. This result was obtained from complete cases only; imputed data did not confirm this finding.

Non-significant findings might be due to some of the methodological shortcomings of this study. First, regardless of imputation of missing attainment data, the number of children with suitable data was very low. Wide confidence intervals indicated imprecision of detected effects which can be explained by a small sample size leading to an underpowered study and future studies should aim to include more children in the analysis. An a priori sample size calculation was not performed because this study was a feasibility study. Present findings may inform an a priori sample size calculation for an adequately powered future study.

Second, attainment measures were assessed by teachers in a non-standardised manner which might have introduced bias. Non-standardised attainment assessment is likely to vary between classrooms and schools and since the study cohort attended different schools educational attainment might be an unreliable outcome measure which does not reflect the true intervention effect. Coding of educational attainment as binary outcome could also explain undetected intervention effects. When dichotomising educational attainment as meeting attainment expectations or not, important information get lost and thus sensitivity reduces to detect a beneficial effect of the weight management. Moreover, post-treatment attainment assessment differed for each child because of varying referral time points to the intervention programme. On average, post-treatment attainment assessment was three months for reading attainment, five months for mathematics attainment and six months for writing attainment. Although it is possible to control for time variation in statistical analyses, short-term and longer-term effects of the intervention might be mixed up, resulting in overall non-significant findings. In addition, the intervention duration might not have been sufficiently long for the given intensity (in total 6-8 sessions over three to five months) to yield in statistically significant changes in educational attainment.

Third, it is also plausible that POST showed no actual beneficial effect on educational attainment. POST emphasises behaviour change strategies, primarily dietary changes and reducing sedentary time (screen time); however an active

physical activity intervention component is missing. Since evidence from Chapter 3 suggested that physical activity interventions appear to have the greatest potential to impact beneficially on educational attainment, intervention components offered by POST might not be sufficient to change educational attainment of overweight and obese children.

Therefore, no evidence of a beneficial effect of the intervention on educational attainment might be explained by a number of methodological shortcomings. Future studies taking methodological flaws into consideration, may be able to better inform the extent to which primary care weight management programmes can benefit educational attainment.

#### **4.4.3. Implications for research**

Findings from this feasibility study suggested that cross-sectorial data linkage of primary care weight management and Pupil Census and attainment data is feasible from a legal, ethical and technical perspective. However, whether participation in a weight management programme has an effect on children's educational attainment could not be sufficiently explored in this pilot study, potentially due to a low sample size, unreliable attainment measures and lack of important covariates.

This data linkage study combined data from one NHS health board in Scotland (NHS Tayside) and two local education authorities (Angus Council and Dundee City Council). The sample size could be increased by linking weight management and education data across Scotland. Both education data and child weight management data are routinely collected Scotland-wide. Although child weight management interventions may vary in intensity, duration, delivery mode and target population, all aim to reduce overweight and obesity in children and are evidence-based programmes. Variability of attainment measures across Scotland and improved sensitivity of attainment assessment could be achieved by using standardised national educational attainment data. SQA National Qualifications are obtained through standardised assessment of educational attainment mandatory for all pupils from S4 and unaffected by the recent curriculum change to CfE. For

example, future research could focus on child healthy weight intervention cohorts from 2010-2013 (year of referral) linked with attainment measures from the corresponding following school years, i.e. 2010/2011, 2011/2012, 2012/2013 and 2013/2014. This would create four study cohorts (SQA results from four school years) which could be used to assess the effect of participation in child healthy weight interventions during a defined period prior to attainment assessment. Using attainment data from different school years may allow exploration of the impact of time between participation in intervention and attainment assessment, taking intervention characteristics (e.g. lifestyle components, duration) into account. The following research questions may be answered which can then inform policy improvement and continuation of the child healthy weight initiative:

- Do child healthy weight interventions result in immediate or delayed change in educational attainment?
- Are there long-term benefits in educational attainment in the intervention group (completers) compared to the control group (not-opted in or non-completers)?

Furthermore, child healthy weight intervention and education data could be linked with additional health records and/or survey data to obtain information on potential confounding and mediating variables. Controlling for additional information in the statistical analysis may strengthen the confidence that changes in educational attainment are due to the intervention. On the other hand, additional variables may help to identify factors that are attributable to the variability in educational attainment of overweight and obese children in Scotland.

With sufficient resources, careful ethical and methodological consideration, and reliable and validated attainment assessment tools, future research could employ a true experimental study (RCT) to assess the effect of weight management on children's educational attainment.

#### **4.4.4. Implications for practice**

Findings of this study suggested that current administrative weight management and education data have limitations in the quality of recorded data in terms of completeness and type of data items. Improved recording of routine administrative data using standard protocols is needed, not only for potential access for research, but also for a comprehensive evaluation of current services, where results may influence intervention and policy implementations. Introducing POST to the services of HIC for the purpose of this study had positive effects on the data management practice of POST beyond the present study. As a direct consequence of this study, HIC have developed a central database for all participants who were referred to the NHS Tayside child and also adult weight management service which will support data management and increase quality of recorded data.

Optimal child development depends on various emotional, social, psychological and physical factors. To ensure adequate support and supervision of children, particularly of children at risk for disadvantaged development, routine data-sharing between the health and education sector is required. School performance related information could be used to inform efficient weight management interventions. In turn, schools and teachers may benefit from child healthy weight intervention data to support weight management and general development of the child in an environment where overweight and obese children often experience social discrimination and emotional distress.

#### **4.5. Conclusion**

Cross-sectorial data linkage provided a unique opportunity to explore associations and effects of a primary care child weight management programme on participants' educational attainment, otherwise only possible in costly and potentially ineffective experimental research projects. Data linkage of child weight management data and education data is legally, ethically and technically feasible on a local level. To date, the Scottish Data Linkage Framework has been developed which offers great potential to perform a similar data linkage with Scotland-wide weight management

and education data, accessing both data sources centrally via the Information Services Division of the Scottish Government.

Up-scaling of the present study is necessary to fully investigate the potential benefits of a child weight management intervention on educational attainment in overweight and obese children. This study used data from one weight management intervention and two local education authorities which appeared to be insufficient to explore the research question on effectiveness. Findings indicated a non-significant benefit of completion of weight management on reading, writing and mathematics attainment. However, due to the timing of the intervention implementations and changes in the school curriculum, the study might have been underpowered and non-standardised attainment measures might have resulted in non-significant findings. Future studies should link data from all *Child Healthy Weight Interventions* in Scotland with a standardised school attainment measure which was not affected by the recent change in the Scottish school curriculum, and should do this, using the services of established and approved data linkage systems.



## **Summary: Effectiveness of childhood weight management on participants' educational attainment**

### ***Findings:***

- Cross-sectorial ad hoc data-linkage is legally, ethically and technically feasible to be implemented in a definitive study examining the effectiveness of lifestyle interventions for weight management on overweight and obese children's educational outcomes
- Available pilot data showed no evidence of a beneficial effect of a primary care child weight management programme on reading, writing and mathematics attainment in overweight and obese children
- No evidence of a beneficial effect of the intervention on educational attainment might be explained by methodological shortcomings (e.g., low sample size, non-standardised educational assessment) and missing emphasis on active physical activity intervention components

### ***Implications for research:***

- Increase the sample size by linking weight management and education data across Scotland
- Improve reliable outcome measure by using standardised national educational attainment measures unaffected by the recent curriculum changes

### ***Implications for practice:***

- Need to improve recording of routine administrative data using standard protocols
- Requirement of routine data-sharing between the health and education sector to ensure adequate support and supervision of children at risk for disadvantaged development

## CHAPTER 5 – Body weight and school experiences: Perceptions of overweight children and their parents

**The aim** of this study was to explore potential mechanisms to explain how lifestyle interventions for weight management might benefit educational attainment of overweight children by addressing the following objectives:

- To explore overweight and obese children's and their parents' understanding and experiences of the association between obesity and school experiences, including educational attainment.
- To gather perceptions of overweight and obese children and their parents on the role of lifestyle interventions to improve school experiences and educational attainment.

### 5.1. Introduction

Findings from randomised controlled trials, reviewed in study 1, suggest that lifestyle interventions can benefit educational attainment and some related cognitive abilities in overweight and obese children. Study 2 has shown that it is feasible to explore the effectiveness of lifestyle interventions applied in a primary care setting on educational attainment. However, both study 1 and study 2 did not provide sufficient data to explore how lifestyle interventions can benefit educational attainment of overweight or obese children. Based on observational studies, several plausible mechanisms were proposed in Chapter 2 of this thesis. Obtaining individual perspectives from participants of weight management programmes allows the opportunity to explore how lifestyle interventions for weight management could benefit educational attainment. Furthermore, for the development of effective health care interventions, it is important to consider the understanding, views, motivations,

and attitudes of the target population to gain insight to their needs (Bartholomew et al., 2011).

Researchers and practitioners have obtained insight into the challenges and barriers overweight or obese children and their families face in daily life and during the attempt to lose weight (Burnet et al., 2008; Grow et al., 2013; Murtagh et al., 2006; Owen et al., 2009). These views were already incorporated in some weight management interventions (Holt et al., 2008; Pittson & Wallace, 2011) as well as experiences of overweight or obese children and their parents who successfully managed their body weight (Lorentzen et al., 2012; Stewart et al., 2008).

In interviews and focus groups, overweight or obese children expressed their negative experiences in school and with peers in terms of stigmatisation, bullying, and social isolation (Curtis, 2008; Davis & Davis, 2008; Holt et al., 2008; Lieberman et al., 2009; Murtagh et al., 2006). For example, Davis and Davis (2008) conducted three focus groups with 17 obese children aged 8-11 years. Using the constant comparative method, a dominant topic was peer relationships which reflected children's experiences of weight related teasing and bullying and limited opportunities to build friendships (Davis & Davis, 2008). Murtagh et al. (2006) reported, based on thematic framework analysis, that the main reason for wanting to lose weight for overweight or obese children (N = 20) aged 8-14 years was to overcome 'humiliation of social torment and exclusion' (Murtagh et al., 2006). Similar experiences were shared in other focus group studies involving 22 overweight adolescent boys and girls aged 14-19 years who either lost or gained weight over a period of two years (Lieberman et al., 2009) and by 18 overweight adolescents aged 10-17 years who participated in a weight management programme (Curtis, 2008). Furthermore, adolescents mentioned health consequences such as glucose intolerance and diabetes as obesity-related co-morbidities (Lieberman et al., 2009). However, these studies did not explore whether overweight and obese children view psychosocial stress (bullying, social isolation) and health consequences as factors associated with their educational attainment. Nevertheless, a

response cited of one participant in Curtis' (2008) study indicated engagement in school work as a coping strategy to avoid stigmatization or exposure to bullying.

Child and adolescent perceptions about a link between childhood obesity and school performance was described in studies which recruited children and adolescents from the general population. Doutre and Manfield (2010) conducted semi-structured interviews with eight children aged 9-10 years. Using the thematic analysis approach, the researchers reported that the children perceived weight-related teasing and physical incapacity as barriers to access educational and social opportunities (Doutre & Mansfield, 2010). Children also linked obesity to ill-health affecting school attendance (Doutre & Mansfield, 2010). Similar findings were reported by Zeller et al. (2008) who asked 76 normal-weight children and adolescents aged 8-16 years about the perceived academic competence and health indicators of obese peers (Zeller et al., 2008). Participants perceived obese peers as being ill and missing school more often. However, academic competence in terms of engagement in school work was not perceived as different from normal-weight classmates (Zeller et al., 2008). Caird et al. (2011) interviewed 17 normal-weight adolescents aged 12-17 years about their understanding of the relationship between obesity and educational attainment. Most of the participants did not see a link between obesity and educational attainment but both obesity and educational attainment were considered as important issues (Caird et al., 2011). Adolescents understood that family income, poverty, bullying and emotional health were factors which may explain an association between childhood obesity and educational attainment (Caird et al., 2011). In an online survey, 1224 children and adolescents aged 8-18 years, of which 25% reported to be overweight, were asked how worried they were about school (Economos et al., 2012). The majority of participants (88%) believed that overweight children are more likely to be teased or made fun of in school and 75% of the children who self-reported to be overweight worried about doing well in school (Economos et al., 2012).

In summary, overweight and obese children may experience greater exposure to potential mediators of the association between childhood obesity and educational attainment, such as psychosocial stress and impaired physical health. However, most

studies did not explore these factors in relation to educational attainment. Perceptions of normal weight children about childhood obesity indicate a link between being obese and experiencing educational disadvantages.

### **5.1.1. Aims and Objectives**

Lifestyle interventions for childhood weight management not only promote a healthy body weight and lifestyle but may also improve school achievement. The majorities of studies which obtained views and perceptions of overweight children focused on their understanding of obesity and experiences in various contexts (e.g. school, weight management programmes). However, there is a lack of literature exploring overweight children's and adolescents' understanding of the link between childhood obesity and school performance, and body weight-related experiences and school performance. Therefore, the aim was to explore potential mechanisms for how lifestyle interventions for weight management might benefit educational attainment of overweight children. The objectives of this study were as follows:

- 1) To explore overweight and obese children's and their parents' understanding and experiences of the association between obesity and school experiences, including educational attainment.
- 2) To investigate obese children's and their parents' perspectives regarding the role of childhood weight management programmes for improvement of school achievement

## **5.2. Methods**

### **5.2.1. Study design and recruitment**

An explorative, qualitative study design using focus groups and interviews was chosen to obtain a richer and more detailed understanding of participants' views and perceptions.

Identification of overweight or obese children and adolescents from the general population may have ethical implications. Therefore, this study was conducted in collaboration with the primary care childhood weight management programme Get Going (NHS Lothian). Similar to POST, Get Going is offered to

families as part of the government initiative HEAT (The Scottish Government, 2013a). Families of clinically overweight children (BMI ≥ 91th centile relative to the UK 1990 reference population) can self-refer to Get Going or are referred by health professionals such as their general practitioner, paediatric practitioner, or school nurse. Get Going is offered at various local community venues, for example in sport and leisure centers, in Edinburgh, East Lothian, West Lothian and Midlothian. Participants for this study were recruited from community venues based in Edinburgh.

### **Ethical considerations**

*Participant identification and recruitment.* Participants were identified by Get Going staff based on adolescents' age. The first introduction to this study occurred by a Get Going coach on either the day of the last scheduled weight management group session or final individual session. I was present on these sessions and explained the study in detail to potential participants after the Get Going session was finished. A written study information package including consent forms for parents and adolescents, in age appropriate language, was also provided (Appendix 8.4.4 - 8.4.9). Contact details of the researchers were offered to give participants the opportunity to ask questions about the study. Young people and their parents/carer had the opportunity to take the information home for further consideration. Participants were given one week to decide whether they wanted to take part in the study.

*Obtaining consent.* Parents/person with parental responsibility were asked to sign the consent form for their own participation in duplicate (one for the participant, one for the researcher) and to either return the consent forms a week later on the day of the final one-to-one Get Going session if they wish to participate in the study or on the day the focus group/interview took place.

I obtained consent/assent from the young people who wanted to take part in the study after the final one-to-one Get Going session took place. I explained the study again and answered further questions if required. Prior to obtaining consent the Get Going coach decided whether the young persons were competent to consent on their own behalf. If so, adolescents were asked to sign the consent form. If not, the

parent/person with parental responsibility was asked to sign the consent form on the child's behalf and the young persons were asked to give written assent. All participating adolescents were competent to consent on their own behalf.

This study was approved by the University of Edinburgh, Moray House School Research Ethics Committee, the NHS South East Scotland Research Ethics Committee and the NHS Lothian Research and Development Office (Appendix 8.4.1 – 8.4.3).

### **5.2.2. Participants**

#### **Inclusion and exclusion criteria (sampling strategy)**

All overweight or obese adolescents aged 10-15 years and their parents who participated in the childhood weight management service Get Going were eligible to be included in this study. This age group was chosen because children in this age range are about to experience or have experienced already, a transition from primary to secondary school which was shown to have an impact on lifestyle choices and educational attainment. In addition, children of this age are better able to self-reflect on their thoughts and feelings and articulate these clearly compared to younger children.

Participants where the adolescent is home-schooled were excluded from the study as well as participants who were not English-speaking. Sufficient proficiency in English language was required to engage in group discussions or interviews held in English language. Adolescents who were home-schooled at the time of the study and during the course of Get Going were inevitably assumed to miss out body weight related experiences in school which was the main focus of inquiry of this study.

#### **Number of participants**

I intended to recruit at least 10 children and 10 parents, yielding in at least two parents and two children focus groups with five participants in each group. I aimed to recruit 15 children and 15 parents to allow for attrition. Focus groups of five to six

participants are adequate to gain understanding of participant experiences through group discussions and group dynamic while ensuring a comfortable setting for the participants (Krueger & Casey, 2009). Individual interviews were planned to be carried out if the number of participants was too low to conduct focus groups and/or participants wished to be interviewed individually.

However, external circumstances described in the following paragraph allowed approaching only 14 families (9 girls, 5 boys). Of those, five adolescents (four girls, one boy) and four parents/carers were willing to participate in this study. Therefore, the participation rate was 36% (five families).

Recruitment of the population group of interest turned out to be difficult for the following reasons:

- 1) Ethical reasons: approaching families for research after the treatment programme finished to avoid distraction and potential drop-out from Get Going due to research queries;
- 2) Access to relevant families: i) low opt-in and completion rate of the weight management programme reduced the number of approachable families, ii) low attendance rate at the ethically appropriate time point (final one-to-one Get Going appointment) to introduce the study to participants;
- 3) Timing of recruitment: the recruitment of participants took place before or at the summer school holidays which made participation in the study difficult due to vacations away from Edinburgh.

Therefore, only one girls' focus group of three participants and one focus group with their parents/carers (i.e. three parents/carers) were conducted. Participant number, time and location restrains did not allow to set up further focus groups. Thus, individual interviews with one girl and her mother were conducted. I intended to recruit an equal number of both boys and girls to ensure an equal representation of



gender. However, given the low participation rate of boys the focus of this study changed to female adolescents and their parents/carers only.

### **5.2.3. Data collection procedures**

#### **Participants' characteristics**

Participants' socio-demographic characteristics were collected using a questionnaire (Appendix 8.4.10). The questionnaire was included in the study information package to be completed by the parents only. Demographic information included but were not limited to name, age, ethnic origin, parental education, employment status, child's living arrangements, number of children, participating child's name, age, gender, school grade, and type of attending school. This sensitive information was treated confidential. A note on the questionnaire reassured confidentiality. Pre/post treatment BMI and BMI percentiles were obtained from Get Going records provided by the Get Going coordinator.

#### **Participants' perceptions and experiences**

Participants' beliefs, experiences and understandings were obtained in separate focus groups/interviews for parents and youths. With support from supervisors and an experienced qualitative researcher (AN) a semi-structured focus/interview group guide was developed. The focus group/interview guide was informed by findings of the previous two studies presented in this thesis (chapter 3 and chapter 4) and evidence from the literature. Open-ended questions followed by probes were used to allow adolescents and parents to describe their experiences. Topic fields included introduction, beliefs and attitudes towards body weight, obesity and school experience, and weight management and school performance (Appendix 8.4.11).

Focus groups and interviews lasted between 60-90 minutes with the youth's focus group being longer than the parent/carer focus group. Both, parent and youth focus groups took place at the premises of the University of Edinburgh, Institute for Sport, PE and Health Sciences. Individual interviews were arranged to suit the requirements of the participants and took place in the families' home (interview with mother and daughter).

Focus groups of parent-child dyads were conducted at the same day in consecutive sessions. Youths' focus group session took place first followed by the parents' session. During the parents' focus group session youth were offered to participate in a physical activity group delivered by qualified physical activity instructor for children (Get Going coach). The physical activity group ensured supervision and functioned as reward for participation in the focus group. Young people who did not want to participate in the physical activity group were free to go with parental permission or were supervised by a research colleague. Young people were asked to bring something that keeps them occupied such as a book or computer game. All adolescent girls participated in the physical activity group session.

Participants of the focus groups already knew each other from Get Going group sessions which allowed a comfortable and encouraging group discussion environment. Participants were informed that they do not have to answer questions if they feel uncomfortable. Confidentiality of responses were reassured before and after focus groups and interviews, and an explanation was given regarding what will happen to the data collected. Ground rules for focus groups were developed and agreed on such as not to talk over each other or to laugh about someone's response and to respect others response to ensure that everyone can be heard and is encouraged to express his/her thoughts.

#### **5.2.4. Data analysis**

Focus groups and interviews were recorded using a digital voice recorder. I transcribed audio recordings and transcripts of individual responses were anonymised by allocating unidentifiable pseudonyms. Data were analysed using NVivo 10 (NVivo, 2012).

#### **Thematic Analysis**

Given that the aim of this study was to explore participants' beliefs, understandings and meanings of their experiences, data were analyzed using Thematic Analysis (Braun & Clarke, 2006).

The textual data were analysed by viewing the transcripts as a collection of sequences. A sequence was defined as one meaning unit containing the essence of a particular meaning mentioned. Sequences were single words, phrases, sentences or entire paragraphs. The sequences were coded by giving a label to them describing the content of the meaning in a concise manner. Codes were derived on the bases of (i) specific theoretical interest which emerged from study 1 and 2 leading to the research questions of this qualitative study, and (ii) recurrent topics and meanings in the interviews and focus group. Thus, I applied a data-driven coding strategy which is often referred to as inductive coding (Fade and Swift, 2011). Furthermore, codes were of literal nature which means they described directly the meaning of the sequence without interpretation of what was said. Related codes were summarized to themes that were specific enough to be non-repetitive and broad enough to capture a set of meanings contained in numerous sequences across the transcripts (Attride-Stirling, 2002). At the stage of theme generation, focus group and interview transcripts of the girls were combined because participants were sampled as representatives of overweight girls who participated in Get Going. For similar reasons, focus group and interview transcripts of parents/carers were analysed as collative. Themes were explored and underlying patterns identified. Themes that emerged from youths' responses were compared to themes within from parents'/carers' responses. Finally, the research questions (objectives 1 and 2) were addressed by building a chain of arguments derived from emerged themes and thematic patterns.

### **Reliability and validity of data analysis**

To increase the reliability of the data analysis process, a sample of data (20% of the youths' focus group transcript) was independently coded by two researchers (AN and myself). Disagreements in coding were discussed until we reached agreement (which was not formally calculated). Similarly, clustering of themes was performed independently for a sample of derived codes (10% of girls' focus group/interview transcripts) and themes were cross-checked and disagreement resolved through discussions. The agreed strategy for coding and theme generation was then applied to data from the focus group and interview with parents/carers.

To increase the validity of the data analysis, youths and their parents/carers were asked to comment on the findings and how their responses were interpreted in order to check the accuracy of the interpretation. A summary report of findings was sent to the youth and their parents in separate envelopes; one for the teenager and one for the participating parent/carer. Participants were asked for feedback or confirmation by a phone call 10 days after the summary report has been mailed. All participants reported that the interpretation of their focus group/interview responses was accurate.

### **5.3. Results**

This study used group discussions and individual interviews to explore overweight adolescents' and their parents' understanding of the association between obesity and school attainment, gain insight into participants' body weight related school experiences and explore participants' perception of the role of weight management programmes for improvement of educational attainment and/or school experiences. These objectives might help to understand how lifestyle interventions for weight management can benefit educational attainment of overweight or obese adolescents.

The findings of this study are presented in three parts. The first part gives an overview of the participants' characteristics. In the second part I present the findings from the focus group and interview with the youths and the last part describes parents' perceptions and experiences. These findings are presented using the terms higher order, lower order and basic themes; representing the stepwise clustering of smaller meaning units (basic themes) into overarching topics (higher order themes). Some of the basic themes have also sub-themes which are described in detail where appropriate. To illustrate themes, quotes from the raw data are presented. The quotes were not edited in terms of grammar and language, typical for a Scottish dialect, to ensure accurate reproduction of participants' responses. Participants are introduced under pseudonyms.

#### **5.3.1. Participant characteristics**

Data were analysed for eight participants, four girls and four parents/carers. The girls were aged between 12 years and 15 years attending secondary school (S1-S5) of

which two girls attended a private school and the other two a state school. None of the girls had to repeat a school year. Three girls live with both parents whereas one girl is living with her mother only. Half of the girls have older siblings. The average BMI of the girls before participation in the weight management programme was 32.9 kg/m<sup>2</sup> which represents a body weight status of the age and gender specific 99.6<sup>th</sup> percentile relative to the 1990 UK reference population. None of the girls improved their body weight status after completion of the programme.

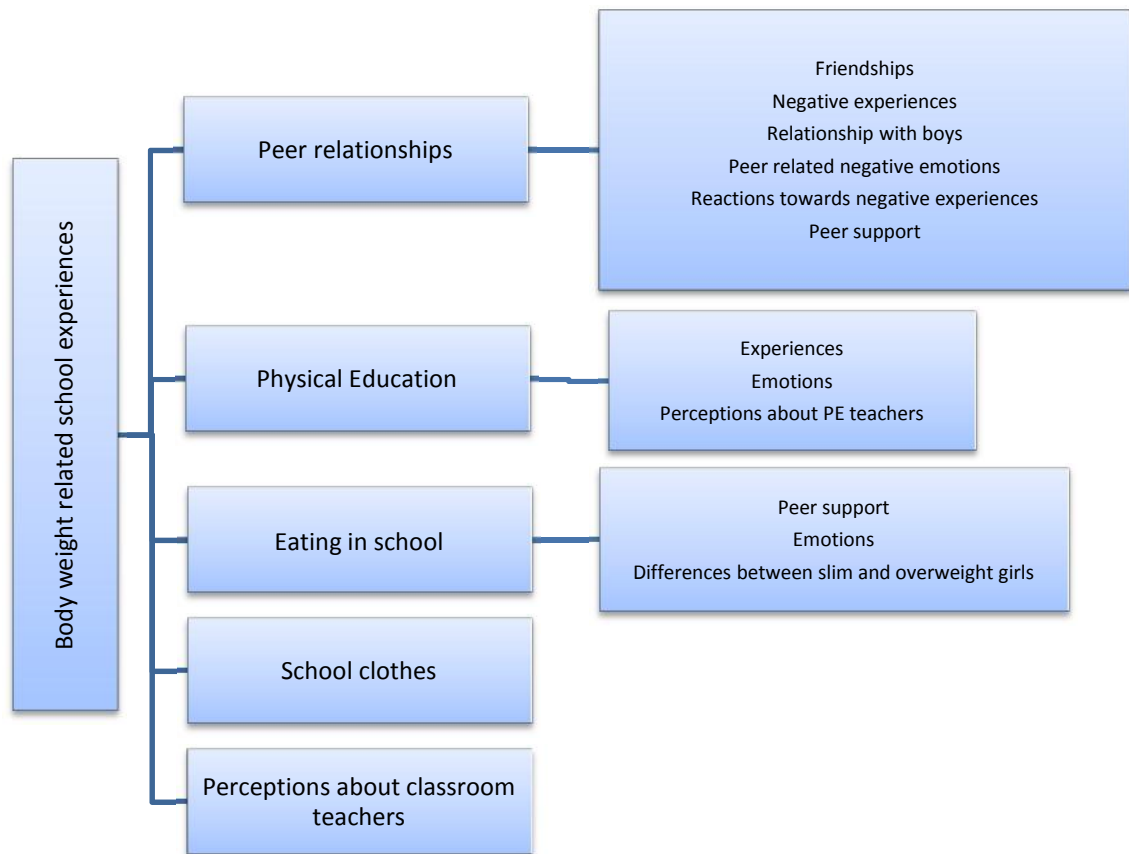
Adult participants included two mothers, one female carer and one father. Three of them were employed for wages and one mother cared for her husband. All participants were Scottish of white-British ethnicity.

### **5.3.2. Adolescent girls' perspectives and experiences**

In this section I present the findings of the conducted focus group and interview with the teenage girls. Four higher order themes were identified which try to explore the objectives of this study. The higher order themes are (A) body weight related school experiences, (B) attitudes towards school, (C) obesity and school performance, and (D) influence of weight management.

#### **A) Body-weight related school experiences**

This higher order theme is the most complex theme identified and relates to experiences the girls have in the school environment that are directly influenced by their body weight. This theme comprises five lower order themes of which each one has several basic themes (Figure 5.1). Body weight related school experiences were expressed in relation to peer relationships, physical education, eating in school, school clothes, and girls' perception about teachers.



**Figure 5.1: Lower order and basic themes of the higher order theme ‘Body weight related school experiences’**

### **Peer relationships**

Body-weight related school experiences were strongly discussed in connection with peer relationships. This lower-order theme relates to the girls’ perception of and experiences with classmates and other peers in school. Six basic themes were identified: friendships, negative experiences, relationship with boys, peer related negative emotions, reactions towards negative experiences and peer support.

*Friendships.* This theme comprises the sub-themes (i) lack of close friends, (ii) reasons of lacking friendships, and (iii) differences between slim and overweight teens which are not presented in the figure but described below.

In relation to lack of close friends, the girls reported that they do not have many good friends in school because they describe themselves as being unpopular and that they

do not get on well with their classmates. This was evident by Margaret's comment: *"Not well. I'm not that popular."* as well as by Kirstin's response: *"Yeah, because sometimes with my friends, although I don't have a lot close friends..."*.

In relation to reasons for lacking friendships, the girls perceived that other girls' lack of understanding of their body weight issues, peers gossiping behind their back and the fact that the girls are overweight itself are the reasons for not having close friendships in school. In addition, over time, interests in fashion, appearance and boys grew stronger among slim peers compared to overweight girls, which was viewed as a reason that friendships broke apart. Pamela reported: *"I kinda, I don't really know when it started more. Cos I can think it more or less started in P6 when people got more kind of mature and stuff. And like you started caring about like, like how people look and like "oh is my hair ok?" like "I've got this new designer bag" and stuff. [...] They got really like into boys and make-up and stuff. Quite girly and got a bit more kind of gossipy and stuff."*

In terms of differences between slim and overweight teens, it emerged from the interview and focus group that the girls believed that slim peers have fewer difficulties to find friends, demonstrated by Margaret's comment: *"I don't know if you think the same, but I think these skinny girls make friends easier."* It was perceived that slim peers pre-judge the girls, which prevents them from building positive peer relationships as illustrated by Kirstin's response:

*"Yeah, because, usually you have to be like, say when you start school you always have to look nice and look happy and have a nice figure. We have to look like a friendly person where people would go to and would get to know you. I think that is why I don't have much friends. Because no one really, everybody has just prejudged me and not actually took the time to get to know me."*

*Negative experiences.* Overweight girls sadly reported regular incidences of (i) social isolation and (ii) stigmatisation, bullying and discrimination by peers in the school environment.

In relation to social isolation, the girls described that classmates ignore and isolate them and that they experienced social rejection by peers. The girls described that they get isolated in various situations. Pamela experienced the following in class:

*“Like in classes I’m quite ignored and I think it has to do with like my body weight and stuff. [...] Sometimes. Like, maybe like in the class if there is something going on, I’m looking ‘Oh look at this’. I’m saying something and no one really kinda acknowledges it.”*

Pamela also described that she is usually not chosen for group work during class:

*“I don’t really like it. It’s when they don’t put us into groups and let us choose groups cos then I just kinda wait for everyone to choose and tell the teacher that I don’t have one and then she says ‘Oh, here go with them.’ That’s normally what I have to do.”*

Furthermore she said that she felt that classmates take advantage of her good academic skills and use her to do the ‘unpleasant’ work:

*“And like some of the girls they are quite, they don’t really care about their subjects. So, they just end up pushing all the work onto me because they know I can do some of it. [...] Well, basically like in let’s say Chemistry [...] I get all the stuff, I write all the stuff down and they all want to do like ‘Oh, I want to melt the metal and I want to put this stuff in here’. They’d do all the fun stuff and I’m just doing the writing and setting up and stuff while they’re just chatting away.”*

Other girls reported that they get isolated when trying to buy healthy lunch. For example Hannah reported:

*“When you are staying for lunch you kinda get isolated because you don’t, if you don’t go outside with them, then it would be like ‘oh nice staying in’ and then when you go outside you are just tempted by sweets and all that.”*

Similar was evident by Kirstin’s comment: *“But then when you say I want to go to Tesco and want to go to the fruit aisle they always say ‘I don’t really want to go*



*there'. So, then you end up going somewhere different because you don't wanna buy anything from that shop."*

Hannah also described rejection by peers during recess: *"You can't even go up and ask them 'Oh, what do we have next?' They just give you a look like 'go away from me'.*

Other situations where the girls are exposed to isolation and stigmatization are when they want get clothes for school work which is often too small for them. For example, Margaret said: *"You get isolated because when you go to science and stuff you get science jacket, lab coats to put on."* and Kirstin stated: *"Everybody, just about everybody else has one that fit them and they make fun of you because you have to go and get something else that does fit you. And you are completely different to what other people have got."*

It was evident that the girls believed that slim peers in school isolate, ignore and reject them because slim peers feel superior as illustrated by Kirstin's comment: *"That is exactly what is in my school. They all look down on me. Like, if you are not in the highest group then they all like, in a way, they...[...] They think they are better than you."*

In relation to experiences of stigmatisation, discrimination and bullying, the girls reported that exposure to negative body weight related bullying occurs on a regular basis in the form of laughing about the girls, talking behind their back and circulating body weight-related rumours. According to the girls, in conflict situations, slim peers use the higher body weight of the girls as an argument against them because, according to the girls, peers know that this is the girls' weakest point, for example:

*"Yeah like, sometimes, when you have like, when someone just, see you have an argument with your friend and you were like upset and they have been really nasty to you the first thing they would say would be 'oh well you are fat'. They would just bring that up. Like every time. If someone is being mean*

*to you and you try to stick up for yourselves that's the first thing they come up with.*" (Hannah)

*Relationship with boys.* Kirstin reported that most of her close friends are boys and that she has a better relationship to boys than to girls in school. On another issue, some of the teenage girls are starting to become interested in boys and are frustrated and jealous that boys are more attracted to slim girls as illustrated by the following comment:

Margaret: *"Boys, I think, are attracted to skinnier girls."*

Hannah: *"Yeahh... A lot!"*

Kirstin: *"Definitely."*

Asking about how this makes them feel, they answered:

Kirstin: *"Depressed. Depressed and depressed, because you are not like that. Sometimes you think you get jealous though."*

Hannah: *"Yeahh...because all your friends go like 'Oh, I have this boyfriend'. And like that 'and me and this are doing that'. And you think, yeah, must be nice to have a boyfriend. You are just kinda like sit there like yeahhh..."*

On the other hand, the girls also mentioned that boys tend to tease overweight girls but when they do so they do it in a direct way other than female peers who tease behind the girls' back. This was evident by Margaret's response:

*"A boy in my old school, he used to say 'obeast' like beast. He would go [girl sings] 'Fatty, fatty boom boom. Fatty, fatty boom boom here they come'. [...] A boy would go [louder voice] 'Oh you are fat!'. They would say it to your face. [...] Whereas a boy would say it, there is a problem and just shut up."*

*Peer related negative emotions.* Being ignored, rejected and bullied makes the girls feel "horrible" and they are "annoyed" when peers laugh about them and take advantage of their academic abilities. The girls mentioned that they feel like being

second class to their peers. Negative experiences and problems with building close peer relationships cause feelings of not belonging; that they don't fit in:

*"In my school I felt I didn't belong anywhere because my friends are mean to me sometimes. Then my other friends they don't do anything, like, they are not really my type. I don't really fit with them and then the populars, I don't fit with them either."* (Hannah).

Margaret expressed her anger towards slim peers in saying *"I could probably just snap them in half. They are like wallpaper and you are like a brick of walls."*

*Reaction towards negative experiences.* All girls reported that their primary strategy to deal with negative comments is to ignore them. Occasionally, they reported telling peers to shut up but mostly they believe that sitting the situation out is the best way to get out of it as illustrated by Kirstin's response: *"And you can hear them. You just chose to ignore that. You have just to ignore it. That is what I usually say to them but you can't really say anything back."*

*Peer support.* Meeting peers who experience similar situations of body weight related teasing was viewed as very important. The girls seem to gain confidence and to cope better with bullying experiences when they are with supportive peers as evident by Pamela's response:

*"There is some like areas like I'm walking around with my friends. There was like one time like maybe walking with my friends and someone, there is like kinda those chavy people like maybe walk by or like on a bike or something said like kinda a comment but that's really about it. I didn't really kind of mind it."*

The girls mentioned that they worry less about being exposed to bullying and stigmatisation in school when they are in company with understanding friends. For example: *"Going to school you aren't as bothered because you go 'I've got these people as well'. You starting realise that people are in the same situation. It made you less sort of worried, you know what I mean?"* (Hannah) and *"Then the chitty*

*chitty bang there were quite a lot of other obese girls and they all walked down and would be singing like 'big girls we are beautiful'.*“ (Margaret).

### **Physical education (PE)**

This lower order theme relates to the experiences the girls have in PE directly influenced by their body weight. This theme included three basic themes covering participants' body-weight related experiences in PE, girls' emotions associated with their experiences, and their perceptions about PE teachers (Figure 5.1).

*Experiences.* The girls blamed their body shape for not performing well in PE; however they reported that they kept trying hard to give their best possible effort. They stated that with a healthy body weight they could be better in PE as illustrated by Kirstin's comment: *“You can do more, you can run, you can like yeah like...all the time you do something in PE in school and everyone else is better than you.”* PE appeared to be an environment where the girls are strongly exposed to body weight-related teasing. Peers laugh about girls' performance in PE and the girls experienced negative comments primarily from boys: *“And when I'm running they laugh because they say like 'Oh my god you are carrying two water melons in front of you'. Because I'm like jelly on a plate, basically.”* (Margaret). Exposure to body weight related teasing in PE was also evident by Hannah's description: *“What they do is laugh and talk to another boy about it and would talk to another girl. They all just hang out in a group talking about you.”*

*Emotions.* Body weight related teasing during PE impacted on the girls' self-esteem. It caused a feeling of helplessness with the only coping possibility to leave the class, for example:

*“And you feel like crap because everyone else is like looking at you. [...] You don't know, don't know what to do [...] And I told her [PE teacher] that and she wouldn't take no for an answer. I was just really annoyed and I literally I just walked out.”* (Hannah).

*Perceptions about PE teachers.* Two of the girls had strong negative opinions about PE teachers. Teachers were viewed as being rude and the girls felt ignored and excluded from PE. PE teachers were suspected only to focus on pupils who perform well in sports and those who do not do well are not of interest to PE teachers as illustrated by both Margaret's and Kirstin's comments:

*"Our PE teachers focus on the ones that are good in sport. The ones that aren't...The other day we got told to go back to class, that we weren't wanted because we didn't get into sport day. Sports day is very competitive."*

(Margaret)

*"Honestly, I don't like the PE teachers because they are so rude. When you try to speak to them they just ignore you. It's not like they are talking. They just ignore you. Say, you ask a question, they are not busy or anything, right, and they just say 'I'll speak to you later'. [...] What else is, there is that group that is really, really good at PE. And if you are not good at, they don't really pay attention to you. They don't really encourage you as much as they do ...I don't think I'm, depends what we are doing, but see when we are running, I'm not a really fast runner. I'm like walking behind and everybody else is in front of me. Usually they're supposed to encourage the one that aren't doing so well but they were encouraging the ones that are really, really good."* (Kirstin)

However, Hannah spoke positively about her PE teachers: *"When we are doing normal PE they kinda encourage you. [...] Normally they were really supportive."*

### **Eating in school**

This theme relates to experiences the girls have when trying to eat healthily while at school. Within this lower order theme the participants discussed the basic themes around peer support, their emotions related to eating in school, and perceived differences between eating habits of slim and overweight girls (Figure 5.1).

*Peer support.* It was evident that there were mixed findings relating to the role of peer support. Some girls reported that they do not share with peers their weight issues such as that they participate in a weight management programme. Pamela said that she finds it embarrassing to talk about it with her friends. On the other hand, although Hannah told her peers that she tries to lose weight, peers were unsupportive in obtaining healthy eating habits and that the peers showed a lack of understanding as evident by the following comment:

*“Even my mum says sometimes they [friends] don’t want you to lose weight. Because sometime when I am saying to my friend, ‘look I’m really trying to lose weight’, and they buy sweets and they would have a midnight feast even though I told them not to.”*

Hannah’s peers even laughed when she chose to buy healthy food which was perceived as demotivating:

*“Even if you do buy something healthy they would laugh at you anyway [imitates the laughter]. What should you been trying for? You know what I mean? One day I was walking to school having an apple because I haven’t had time for breakfast. There was a wee couple of boys behind us and they were just like laughing.”*

In contrast, Kirstin felt that because of her body weight she has to choose healthy food to avoid negative comments about her body weight: *“And then whenever I go to the shops I feel I have to always get the healthy choice because they wouldn’t snigger behind my back and ‘oh fatty, fatty’ and stuff like that.”*

*Emotions.* The girls said that it upsets them a lot when their attempt to lose weight is not supported and laughed at: *“It was horrible. Felt like chucking the apple at them.”* When comparing their eating habits with the one of slim peers the girls described that they find it unfair that slim peers can eat as much as they want and maintain a healthy body weight as evident by Margaret’s comment: *“It’s so annoying. How some people can eat want they want and they are still like stickins.”*

*Differences between slim and overweight girls.* The girls observed that their peers in school have unhealthy eating habits. Slim peers eat crisps and sweets for lunch and prefer to choose unhealthy food options over healthy ones. However, the girls reported that these unhealthy eating habits are not noticed by others but the girls said other people judge them when they eat junk food for lunch, for example: *“Like no one really pays attention to that and thinks that is ok. But if there is a fatter person that has it they’re all staring, they all snigger.”* (Kirstin).

Some girls perceived slim girls as greedy and believed that this is because they do not get as much food at home as was evident by Margret’s comment: *“They don’t get the choice. And when they see you with food they come running up, like seagulls basically.”* as well as Hannah’s comment: *“Yeah, when skinny people have food, you see some really skinny people and they have like lots of stuff they buy. You see them with big packets of sweets for their lunch.”*

### **School clothes**

As indicated under ‘negative peer experiences’ the girls face body weight related issues with getting clothes for school that fit. The girls reported difficulties in getting appropriately sized lab coats, PE kits and school uniforms, for example. It is apparent that the girls’ body size is too big for standard sizes available for their age. Therefore, they have to get the uniforms specifically tailored for them. Difficulties in getting clothes that fit exposed the girls to teasing and stigmatization as reported for example by Margaret and Kirstin:

*“Because when you go to science and stuff you get science jacket, lab coats to put on. Mine always pops off and the teacher goes, ‘right your jacket is too small go and get another one, come with me’. And everyone stares. Or even in your school uniform. I’ve got like a kilt and everything. [...] I was getting PE trousers and they were too small for my legs. I had to wait one and a half years for them and even for my house top.”* (Margaret)

*“Say when you do stuff in art and you need to get special tops on and aprons and pinnies [pinafore] and when there is nothing to fit you. [...] Everyone just looked at you. That was just horrible.” (Kirstin)*

### **Perception about classroom teachers**

This lower order theme relates to the girls’ perception about their classroom teachers in connection to their body weight.

Besides the negative perception of PE teachers by some girls, classroom teachers are perceived as non-judgmental towards the girls’ body weight. There were no negative body weight related experiences and teachers are viewed as supportive. Kirstin described that without the support of her teachers she would feel more upset in school. Asking how she is getting on with her teachers she responded: *“Oh lovely! There are all like... Without probably I would be more upset. If my teachers weren’t there, because they are really encouraging.”*

### **B) Attitudes towards school**

Despite the negative body weight related experiences in school outlined above, the girls expressed a positive attitude towards school. They reported that they like going to school and are dedicated to education with aspirations to move on to higher education after they have finished high school. The girls described that they are on time for class, do not miss class on most occasions and that they prefer to be engaged in classwork than talking to classmates. The positive attitude to school was evident by Margaret’s and Kirstin’s responses: *“I think I’m not a geek but I take my education seriously.” (Margaret), “I really enjoy school. School is the thing that matters most in my life.” (Kirstin).*

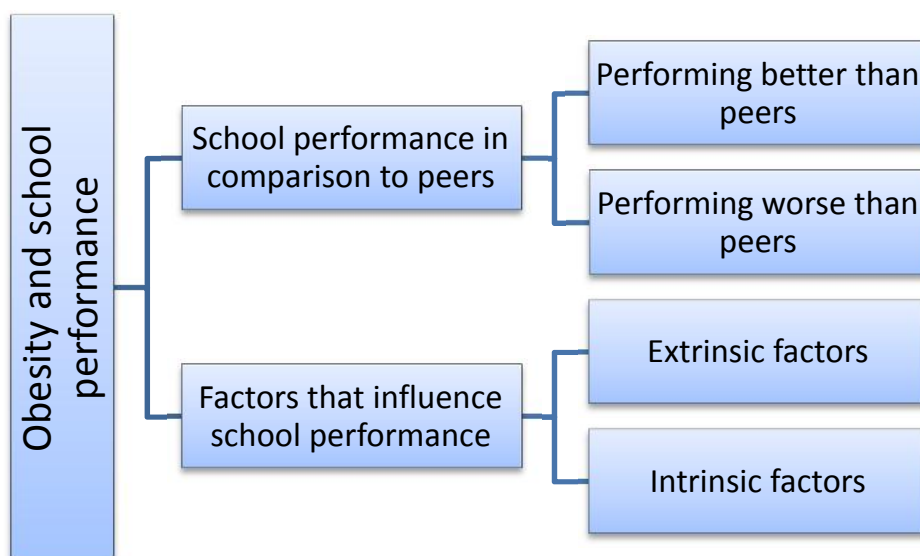
The girls believe that due to their engagement in school work and positive attitude to school they are popular among teachers, for example: *“So teachers like me cos I did like, I did all the work and I put my hand up in class and stuff. So, teacher quite liked me I thought.” (Pamela)*

### **C) Obesity and school performance**

This theme relates to perceptions and experiences the girls have in connection with their performance in school. Within this theme the following two lower order themes



emerged; school performance in comparison to peers and factors influencing school performance. There were two basic themes for each lower order theme. Figure 5.2 shows all themes which emerged in relation to ‘Obesity and school performance’. This section relates to how overweight youth understand the association between obesity and school attainment which is part of objective 1 of this study.



**Figure 5.2: Basic and lower order themes of the higher order theme ‘Obesity and school performance’**

### **School performance in comparison to peers**

This lower order theme relates to the girls’ belief of how well they perform in school compared to normal weight classmates and other peers. The girls had contrasting opinions when comparing the school performance between them and their normal weight peers resulting in the following two basic themes.

*Performing better than peers.* Some girls said that they are better in school than their peers and that they don’t have issues with school as illustrated by the following comments:

*“I don’t think education is a problem.” (Margaret)*

*“In some [subjects] I do quite well much better than them.” (Pamela)*

*“I’m doing really, really well in school. [...] If it is me in the class it would be probably me, it sounds really bad, it would be me getting compliments for my work. I always trying to do my best and I concentrate.”* (Kirstin)

*Performing worse than peers.* The other girls, on the other hand, mentioned that they perform on an average level being neither the best nor the worst, or that their slim friends perform better in school than themselves. For example,

*“I’m not, like, happy. I find it too hard. If a test comes up I move down. You know, just fail it or something. You kinda like, I’m not like the best artist. I’m not the best at anything but I’m not the worst. [...] My friends they are quite smart and like I’m not as good as that.”* (Hannah)

*“Most of my friends are in set one or two and I’m in set four. [...] I’m bottom set and everyone else is like near top.”* (Pamela)

### **Factors influencing school performance**

This lower order theme relates to what the girls perceived as factors that influence school performance. The girls reported various reasons for good and poor school performance which were related to the basic themes (1) extrinsic factors such as the family environment and peers or (2) intrinsic factors connected to pupils’ attitude to learning.

*Extrinsic factors.* Having parents from an academic background was viewed as a reason for better school performance as well as having both mother and father at home. Pamela believed that being raised by a single mother may influence her school performance negatively because she has to look after herself in terms of preparing meals while her peers can focus on school work:

*“Like one of my friend is quite like very academic. Her dad is a Physicist at Edinburgh University and her mum was a teacher in P1 and like nursery. So, she’s got like a quite academic influence on her. [...] I have to cook my own dinner sometimes; their parents cooking dinner like all the time. I have to do kind of other stuff that normally parents would do sometimes.”*

Another external reason for performing less well in school was distraction from class work by peers and missing class as a consequence of peer pressure. This is illustrated by Pamela's and Hannah's responses:

*"Like, one of them is quite like when she is on her own like just in a group with me and some other person she doesn't really go with she just kinda do work. She knows how to do the work and she'll try and stuff. When she is with the other girl she won't try at all just chat all the time."* (Pamela)

*"I got pressured into skiving."* (Hannah)

The lack of good relationships with classmates may allow the girls to focus on school work and getting less distracted by peers as evident by Pamela's comment: *"I was in the same class like for two years and I didn't really like most of them [classmates]. So I got my head into work and stuff."*

*Intrinsic factors.* All girls agreed that doing homework and studying were important to perform well in school: *"...a lot of my friends are as well. They spend quite a lot of time doing homework and stuff like that."* (Hannah); *"She studies a lot, she's like, she's quite kind of studies, does her homework and stuff."* (Pamela). Putting fewer efforts into homework and talking to classmates during class were viewed to be associated with poor performance in school as was evident by the following comments:

*"I quite get involved in school work more. So like I put my hand up quite a lot and just get on with work while people are gossiping and stuff."* (Pamela)

*"Like some of the girls are just chatting and don't doing work and they get like low marks."* (Hannah)

*"Well, I sometimes I don't even study for tests and my homework I kind of leave it last minute sometimes because I hate writing essays. [...] I'm probably either playing my Xbox or my ipod or something like that."*

(Pamela)

In addition, one girl stated that because she is more interested in creative subjects such as art than in science she is not as good in school as her peers.

Body weight was not perceived as a factor which determines school performance. Pupils' attitude to learning was seen as the main influence on school performance, for example:

*"I don't really think it [body weight] matters. It kinda just depends on how like your personality sometimes. If like they, like there is a few girls that are really skinny they just do work and just get through stuff and then they chat with their friends like 'You're loud too' and stuff and some just like don't even bother. So, I don't think it kind of really matters at lot in our school. It kinda just depends on the person really. [...] kinda just depends, I'm trying to think of the right word...it's like opinion type like...their attitude towards school. If they care what they wanna be and they don't just want to rely on their parents for stuff."*

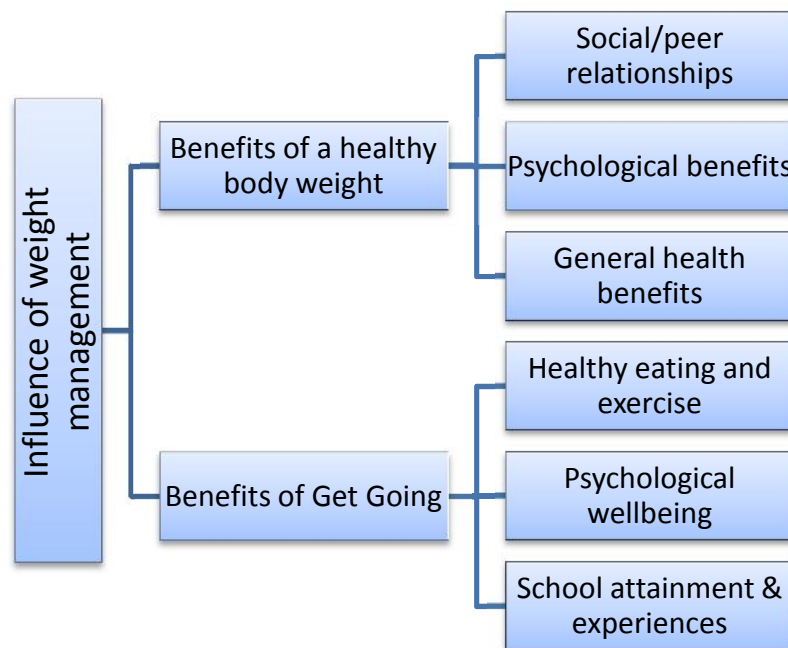
(Pamela)

*"It depends on the person, if you know what I mean? If it's a person that didn't really try in school because they think they had no future, not future but not caring anymore, you know? They don't fit in, sittin' there 'I hate this, I hate this, I hate that'. But if they start getting a better view on things, trying harder."*

(Hannah)

#### **D) Influence of weight management**

This higher order theme relates to the girls' perceptions about the benefits of a healthy body weight and the weight management programme which they were engaged in. Benefits of a healthy body weight and benefits of Get Going were the two lower order themes identified. The girls also discussed how they believed participation in a weight management programme can benefit on body weight related school experiences. This theme is one of the basic themes of 'benefits of Get Going' and addressed directly objective two of this study. Figure 5.3 shows the two lower order themes and related basic themes.



**Figure 5.3: Basic and lower order themes of the topic ‘Influence of weight management’.**

### **Benefits of a healthy body weight**

Participants discussed what they perceived to be the benefits of being healthy and having a healthy body weight referring to the social life and peer relationships, to psychological benefits and to general health. These themes formed the basic themes shown in Figure 3.5 and described in detail below.

*Social/peer relationships.* The girls reported that being healthy allows a teenager to go to school, have friends and to dress smartly. Having a body weight in the normal range was viewed as beneficial for making friendships, approaching boys and being able to buy any clothes they like and not being restricted by what is available in bigger sizes. Hannah mentioned that she wants to lose weight to have normal teenage life:

*“I felt this was kinda my last chance to have a normal teenage life. I would like to go uptown with my friends and buy all the clothes and go to young night clubs. I still go to them but my dresses aren’t as nice as theirs and they have nicer clothes. They can just go uptown and pick what they like. And I*

*always wanted to do that. I know that is quite stupid [giggles] but I always had the dream to go on holiday and to wear a bikini.”*

*Psychological benefits.* There was agreement amongst the girls that a healthy body weight would benefit their self-confidence and they would feel better about themselves which was perceived to be crucial for talking to other people: *“I’d probably would feel better about myself, talk to more people and stuff cos right now I kinda like ignore people.” (Pamela)* Gaining self-confidence was one of the reasons why the girls wanted to lose weight as was evident by Pamela’s response: *“Cos I had and still do have quite low self-confidence. And most of it stands from like body weight and physical appearance and stuff. So I felt, right, if I changed some of it I probably would get more self-confident.”*

*General health benefits.* The girls understood that a healthy body weight is important for physical and metabolic health. They described diabetes and cardiovascular diseases as potential health consequences of obesity, for example: *“Yes, cos if you like have more fat in your body it puts more pressure on your heart and like cholesterol level and stuff. So, it kinda does help to contribute to your overall health quite a bit.” (Pamela).* A family history of diabetes and the delay of the onset of diabetes motivated Margaret to attend a weight management programme:

*“My dad has been diagnosed with diabetes and it runs in my family, type 2. I got told that I definitely get diabetes when I don’t lose weight because it runs in my family but I can prevent it if I lose weight and get it maybe in the 90s.”*

### **Benefits of Get Going**

There were three basic themes that emerged from the individual and group discussions around the benefits of Get Going. The basic themes were benefits on healthy eating and exercise, benefits on psychological well-being, and benefits on school attainment and experience (Figure 5.3). The following paragraphs describe these basic themes.

*Benefits on healthy eating and exercise.* The girls reported that participation in Get Going met their expectation to learn about healthy eating and the importance of being physically active. This was evident by Pamela's description:

*"Probably, like it kinda gave me...it taught me more about it cos I hardly knew anything. Like, my mum bought, like when I was young she bought like ready-made meals and stuff and other stuff and I had to cook and stuff and do things like that. And I didn't really know what was best to eat. If I had to like this exercise and stuff. So I didn't really know much about it."*

The girls described that Get Going encouraged them to exercise more often and particularly the peer support they experienced through Get Going motivated them to be physically active:

*"...and when we were doing the exercise as well I was like, when I tried before I didn't really like the gym much, I wasn't doing much exercise and eating my food but now I find a bit like better. So it wasn't that bad."*

(Hannah)

*Benefits on psychological well-being.* From the focus group and interview it emerged that Get Going had the biggest impact on the psychological well-being of the girls. They reported that through Get Going they feel more confident, are motivated and encouraged to obtain a healthy lifestyle, and that they feel happier about themselves. For example, Kirstin reported:

*"I feel all happier about myself than before and my weight and stuff. [...] I feel more determined and when I found out that I haven't lost any [weight] Just stayed the same I was more determined, keep working hard and trying to lose more weight."*

The girls also said that they felt better after Get Going made them aware of the unrealistic body images in magazines. It was evident that being in Get Going and meeting other people who go through a similar situation gave the girls a sense of belonging and support as illustrated by the following comments:

*“It was nice to meet people like, you know what I mean, that feel the same as well. I think this really helped me. When we go out we help each other not to buy rubbish like sometimes with my friends.” (Kirstin)*

*“Probably, like cos there are people in the same situation like I am basically. Just kinda, I don’t really know anybody like that. And I don’t really know people who are going through the same thing and like [Get Going] introduced me to other people like that. And I thought ‘Oh, there are other people who are going through this’.” (Pamela)*

*“It has helped me a lot. [...] Get Going is like, I met other people that I really liked and that. I fitted in with them really well.” (Hannah)*

*Benefits on school attainment and school experience.* The girls perceived that participation in a weight management programme like Get Going can only benefit school attainment if the pupil has generally a negative attitude to school and a negative view of life. They felt that obtaining a positive attitude to life and gaining self-confidence and determination through a weight management programme can help to cope with other aspects in life too:

*“You look at life in a more positive way, once you start saying ‘I can do this’ then you think, you really think like, you share that with all the rest of the stuff you are dealing with.” (Kirstin)*

*“Well, probably just like that whole losing weight thing cos then like I feel more confident and then like probably maybe try like different stuff and like do more opportunities in school.” (Pamela)*

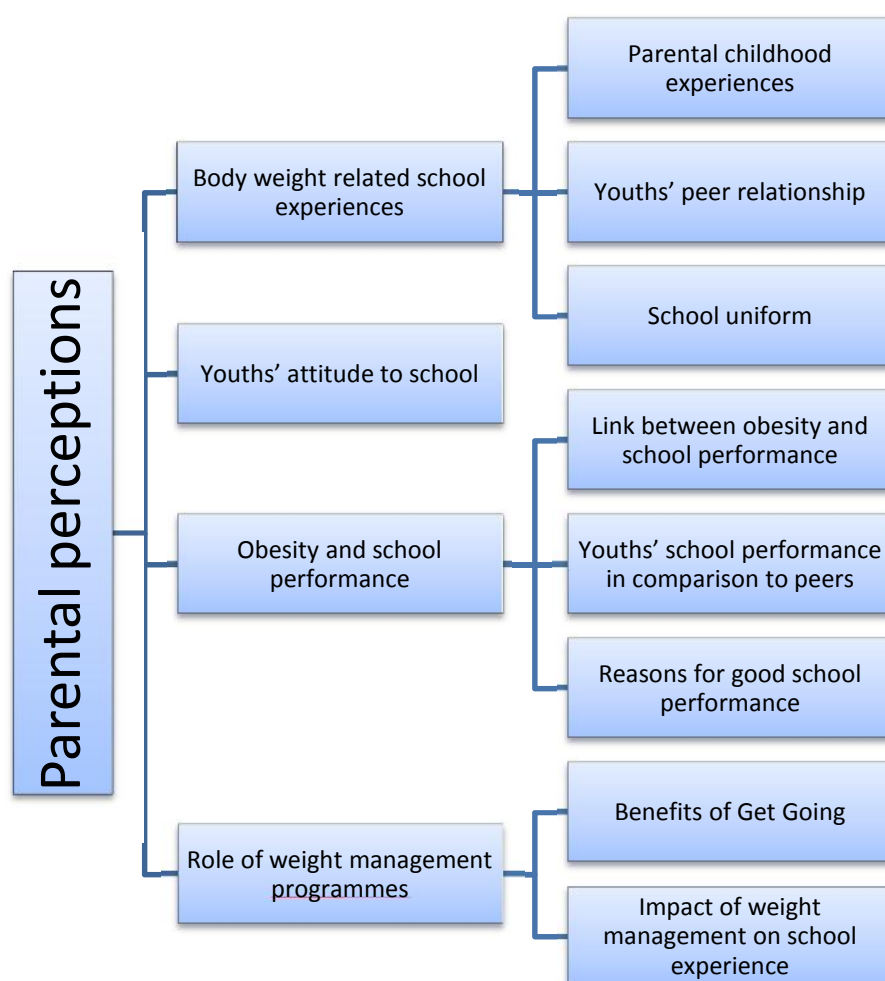
### **5.3.3. Parents’ perception**

By conducting a focus group and interview with parents/carers of overweight adolescents who participated in a weight management programme, I aimed to gain insight into parents’ understanding of the link between youth obesity and school performance (objective 1). Parents’ responses might also assist in understanding how



parents believe a weight management programme can benefit school experiences (objective 2).

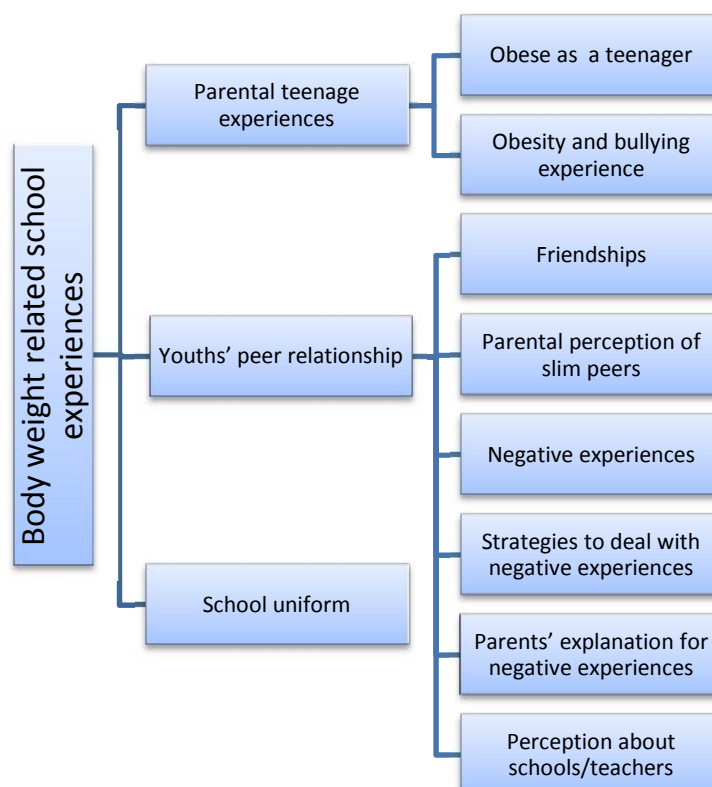
In this section the results of the focus group and interview with parents/carers are presented. To address the study objective the following four higher order themes were identified; (A) body weight related school experiences, (B) youths' attitude to school, (C) obesity and school performance, and (D) role of the weight management programme. Theme A, C and D cover two to three lower order themes. Figure 5.4 shows higher and lower order themes. The following paragraphs describe in turn each theme in detail.



**Figure 5.4: Higher and lower order themes identified from the focus group and interview with parents/carers.**

### **A Body weight related school experiences**

This theme relates to the experiences the parents had in school when they were younger and their view of their daughters' experiences in school directly related to body weight. This theme covers three lower level themes which are parental teenage experiences, parental perception about their child's peer relationship, and issues associated with the school uniform. There were six basic themes within 'youths' peer relationship' which are described in Figure 5.5.



**Figure 5.5: Lower order and basic themes of parents' perceptions about body weight related school experiences.**

#### **Parental teenage experiences**

This theme refers to body weight related experiences the parents had during adolescence. Two sub-themes emerged during the discussion and interview; being obese as child and being bullied because of being obese.

*Obese as a teenager.* Two parents reported that they were obese as a teenager and this impacted negatively on their confidence and social life. For example Hannah's parent reported: *"As a teenager, I mean as a teenager I didn't have a social life, because I was morbidly obese."*

Margaret's parent was never overweight or obese as a teenager but she described that having an overweight friend she never noticed what her friend had to go through. For Margaret's parent, body weight was no factor that would have been a reason to turn the back on the overweight friend:

*"My friend was overweight. We were the best friends and we still are. And one day she did say to me 'Why didn't you tell me that I was fat?' 'This is because, to me, you are my friend whether you be fat or skinny. I love you anyway, whatever weight.' You know? That was just me and her. We were brought up together. I didn't see that, I didn't see that what she was feeling. I didn't see what was going on in her head. I would have never thought that this is happening."*

*Obesity and bullying experience.* Some parents said they were obese and experienced bullying and social rejection during adolescence. Parents described different strategies to deal with being bullied. On the one hand, some parents physically fought back which was supported by a school teacher at the time as evident by Hannah's parent's comment:

*"I got bullied in school. [...] But then I laid hand on a school boy. I was always told to go and see a teacher when I got bullied. I went to the teacher he says 'Why are you telling me? Hit him'. He said 'Look, he is gonna get you whatever you do. I'd rather you did that on school grounds.' He says 'That means I can get him.'"*

On the other hand, Pamela's parent reported that she tried to be engaged in various activities such as sport clubs or working in the school library to avoid exposure to bullies:

*"I did hockey, rock climbing, hill walking, you name it, I did everything. I loved it, you know. It got me away from the bullies. That's why I went into*

*that, I can't read, I used to stay in the library to get away from the bullies, people that would persecute me."*

### **Youths' peer relationship**

This theme relates to how the parents perceive their children's relationship with peers in school in direct connection to the girls' body weight. The following six basic themes were identified: friendships, negative experiences with peers, strategies to deal with negative experiences, how the parents explain negative experiences, how they view normal weight peers, and the perception of schools and teachers (Figure 5.5). These six basic themes are presented in turns in the following paragraphs.

*Friendships.* Within this basic theme two sub-themes emerged; lack of friends and reasons for the lack of friends.

In relation to the girls' lack of friends parents agreed that their children need peer-support through friendships. It emerged that peer support can help to cope with low sport performance in school or can encourage taking part in after school clubs. However, parents reported that their daughters have problems in building close peer relationships in school unless, as reported by one parent, the child has grown up with classmates from an early age. Parents believed that the lack of friends has negative consequences in their daughters' psychological well-being. It was reported that during lunch breaks the lack of friends seems to cause anxiety in the girls as illustrated by the following response:

*"At lunch time she is very, very anxious because it's this build up of 'Who am I going to lunch with?' [...] She still goes for lunch and she'd be sitting with the girls but I wouldn't say...she is enjoying it." (Margaret's parent).*

In relation to the perceived reasons for the girls' lack of friends, it was evident that parents believe that confidence is crucial to make friends and to socialize. They reported that the girls lack confidence. They also believe that the girls do not have good friends because of their body weight; that overweight teens are perceived as being different. Clique building in school was also viewed as a factor that might

explain poor peer relationships: *“She’s finding it hard to gel with the girls because there are cliques. And when you go it’s hard to get into that group.”* (Margaret’s parent)

Parents described that another reason for the lack of friend is that their daughters have different interests than their classmates and that they appear more mature than their classmates. Parents reported that the girls are possibly more mature than classmates because they did not have much interaction with other children when they were younger as illustrated by the following comments:

*“I think she is a bit too mature for her age because of the way she’s been brought up. You know, I feel she is older than her years in her mind because she’s been brought up with adults and did not have a lot interaction with children, you know.”* (Pamela’s parent)

*“I think Margaret is older than her years. Like in her class they are like little kids to her. I don’t know if this is because she has been brought up around adults. What they would be laughing Margaret wouldn’t find funny anyway. [...] She talks, she talks like an adult. Yeah, because they are so grown up. The conversations they have are so grown up.”* (Margaret’s parent)

Increased maturity and lack of friends means the girls spend more time in adult company as teenagers: *“But sometimes I think it’s too much time spent with adults instead of their own age group. So it does affect their psyche.”* (Hannah’s parent)

*Parental perception of slim peers.* From the focus group and group discussion it emerged that the parents viewed normal weight classmates of their daughters as being more popular and having more friends. It was evident that the parents had generally a negative perception of their daughters’ normal weight peers. Some parents believe that *“the thin people don’t want to be seen with fat kids.”* and that they are careless for other people. Parents experienced that normal weight peers are unsupportive when it comes to eating healthily and that they do not understand the situation overweight teens are in. One parent believes that normal weight peers do not want the overweight youth to lose weight to feel better about themselves:

*“The skinny ones don’t want the fat people losing weight. Even the pals, they don’t want them losing weight because this makes them feeling better about themselves. [...] Certain ones. I mean, there are exceptions to rule but they don’t have interest as long as they get what they want. Doesn’t matter about anyone else.” (Hannah’s parent)*

*Negative experiences with peers.* This basic theme includes two sub-themes; isolation and being bullied which are presented as follows:

In relation to isolation all parents reported incidences of their daughters being isolated from peer activities or socially rejected. It was evident that isolation and rejection occurs in various setting, for example during class, recess or lunch breaks, as was evident from the descriptions by Pamela’s parent and Kirstin’s carer:

*“And I feel she is excluded. She doesn’t get invited really to go out to the cinema or whatever. [...] a lot of stuff that is going on; being it at the playground, classroom. She feels invisible sometimes.” (Pamela’s parent)*

*“The girls just whisper and run away and she was just wondering what is happening.” (Kirstin’s carer)*

To avoid being left alone, parents stated that the girls do not resist peer-pressure leading them to do things they do not want to do. For example Hannah’s parent reported: *“But because she is with the other kids she will go to McDonalds. You know, again it’s peer pressure. Pure and simple. Just to be accepted by the skinny kids.”*

In relation to bullying, parents described that their daughters are bullied in school by peers, which makes the parents feel helpless and sad. Negative experiences shared ranged from talking negatively behind the girls’ back and humiliation to physical assault as illustrated by the following responses:

*“Hannah got chased from Drummond High School until she actually had to take residence in a church phoning me.” (Hannah’s parent)*

*“They [the boys] were betting on, making bets on asking her to go to one of the dances and then see who would ask her out and then they would decline her. I thought that was pretty cruel. It was just a joke. It was one the girls she used to be friends with that instigated it all. There was lots of little things that happened.”* (Pamela’s parent)

*“She [classmate] distracts her from her work and she becomes childish and she pokes her with her pen. It’s physical and mental sort of stuff that she does.”* (Pamela’s parent)

*“When Margaret was in primary there was a friendship bench. And I thought that idea was disgraceful. All the kids that didn’t have friends they would go sitting on that bench to see if other kids would be friends with them.”*

(Margaret’s parent)

*Strategies to deal with negative experiences.* There were two sub-themes within this basic theme. Parents reported both (i) how their daughters cope with negative peer experiences and (ii) what their strategy is as a parent to cope with and prevent bullying of their daughters.

In relation to the girls’ coping mechanisms, most parents described their girls keeping quiet when being bullied and ignoring the incidences: *“And she seems to be, she said ‘Do you know what, I don’t care mum.’ You know, ‘They say what they want’. She keeps quiet.”* (Pamela’s parent); *“She would turn around to me and say ‘You know what mum, I’m only bothered about my education. I don’t care what they say.’”* (Margaret’s parent)

However, Hannah’s parent reported a physical reaction after Hannah has been bullied: *“I got sent in because she thumped another kid.”*

In relation to the parental strategy to deal with bullying, some parents noted that they are concerned that their daughters could become bullies because of their negative experiences. Parents reported that they tell their daughters to approach an adult

before dealing with the negative experience themselves. This was evident by Margaret's parent's comment:

*"Do you know what the worrying thing about that is? If you would end up being a bully yourself through people bullying you. And that's something you don't want either. That's why I always say to Margaret 'Look, just speak to a teacher if somebody is saying something to you'. [...] I rather have her speak out or even tell her mum and dad."*

Parents believe that the girls need to gain confidence to speak up for themselves. However, they also expressed that there is a limit to what extent someone can deal with negative experiences, for example: *"They just need to learn trying to stick up for themselves."* (Margaret's parent), *"You can only rise above it so much though."* (Hannah's parent), *"You can only put up with it for so long."* (Kirstin's carer).

Despite that, some parents described that they try to help their daughters to cope with negative experiences in school by promoting their self-confidence. Pamela's parent described: *"Luckily what I always told her sort of helped 'Basically, it's not what you look like it's who you are inside is the most important thing and to be kind, be true to yourself but also to be kind to other people.'" Similarly, Margaret's parent commented: "I said 'There is nothing wrong with you'. Do you know what I say to Margaret? 'You know what? They are just jealous, jealous of you.'"*

In contrast, during the focus group and interview it emerged that one parent supports dealing with negative experiences by using physical means: *"I just turned around and said, right in front of the head teacher, 'Well done Hannah. This is what I always told you. If someone hits you first you hit him back.' It was the other kid that hit her first."*

It was evident that in reaction to the girls being bullied, some parents approach the schools to either complain about the lack of anti-bullying policies or to ask them to be aware of the situation and intervene if required.



*Parents' explanation for negative experiences with peers.* Parents believe that their daughters are bullied because of their body weight and because they are good in school. According to the parents, being overweight is seen as a weakness by peers and this motivates them to tease and stigmatise overweight classmates: *"And that was because she got bullied. All because of her weight."* (Hannah's parent)

*Perception about teachers/schools.* Some parents believe that teachers tend to be ignorant toward bullying because they do not want their school to get a bad reputation. For example, Margaret's parent stated: *"I think teachers are ignorant towards bullying. They want their schools to be known as being good schools. They don't want a bad reputation."*

On the other hand, parents also reported that their daughters received support from teachers in the way that teachers took action against bullies or that the school tries to promote positive peer relationships by separating cliques: *"So, the only way that she managed to, she's not have a really good friend in school, is through the teachers."* (Margaret's mother). From the focus group and interview it was evident that teachers seem to play an important role for the girls to cope with their body weight related school experiences, as was evident by Pamela's parent's response: *"And I feel she relates more to the teachers than she does to the pupils."*

### **School uniform**

This lower order theme within 'Body weight and school experiences' relates to the perceptions parents have about the issues their daughters face in connection with the school uniform. Having difficulties to find appropriately sized clothes for the school was an important topic for the girls. For the parents this was not a topic they talked much about. However, one parent confirmed that the school uniform has to be in adult size and has to be ordered specially:

*"The uniform she is ok with that. But we have to order, we have to order specially a kilt for her cos she is a 36 [inch] waist. So it's... They don't sell the kilts for even seniors and I have seen a lot big senior girls. That*

*embarrasses her when we go this or next week to get her uniform. Getting a uniform and she has to get a lady's size and everything."*

### **B Youths' attitude to school**

This is the second higher order theme that emerged from the focus group and interview with the parents/carers (Figure 5.4). The theme relates to parents' perceived attitude of their daughters to the school and education. This theme might help to understand how parents view the link between youth obesity and school performance.

The positive attitude to school and education described by the youths was also confirmed by the parents. They reported that their daughters like going to school, like the teachers and are keen to study at home after school as was evident by the following statements: *"When Margaret comes home she is over her book and doing homework and everything."* (Margaret's parent); *"She's quite confidence in her abilities, you know her education. [...] I feel that, probably she is happy in the class. She loves the teachers."* (Pamela's parent); *"Hannah is already talking about going to university."* (Hannah's parent).

### **C Obesity and school performance**

Similar to the third higher order theme from the focus group and interview with teenage girls, this theme relates to perceptions and experiences the parents have in connection with school performance of overweight pupils in general and their daughters in particular. There were three basic themes; link between obesity and school performance, youths' school performance in comparison to peers, and reasons for good school performance (Figure 5.4).

#### **Link between obesity and school performance**

This lower order theme relates to how parents understand the link between childhood obesity and school performance in general.

When naming consequences of childhood obesity, parents reported psychosocial and health factors such as diabetes, decreased physical stamina, low

self-confidence and limited opportunities to get fashionable clothes and engage in sports. However, from the focus group and interview it was evident that parents did not perceive that obesity is associated with poor school performance. All parents strongly disagreed to a possible negative association between obesity and educational attainment. One parent said that all overweight children who participated in Get Going were intelligent and that the reasons for becoming obese are unrelated to the children's intelligence: *"They were all quite intelligent. They were all very bright children. And I'm thinking 'That is quite odd, they didn't all go to private school.' And I'm thinking they were all very intelligent."* (Pamela's parent).

### **Youths' school performance in comparison to peers**

Asking how well their daughters perform in school compared to their peers, parents reported that their children perform better than peers, even being at the top of the class, as illustrated by the following responses: *"Margaret is top of her class."*, *"So is Kirstin. Brilliant. She is up for awards at the end of the week. She's got an award saying that she has done really well."* Pamela's parent reported:

*"In her sort of educational level, I think she does really well. She is very good in the class. She keeps her head down; she doesn't get into trouble. With Pamela, she's not got the neat bit but when they asked her to do things she actually does what they asked. She does step up when she is under pressure. She does well. She excels. She is not in the top classes but she is higher than the British average. So with George Heriot's their level of education is a lot higher than the state schools."*

### **Reasons for good school performance**

This theme relates to what parents perceive are the reasons for their daughters' good school performance. It was evident that parents believe that being overweight or obese affects school attainment positively. They described that because of their daughters' body weight issues, different interests and the associated lack of friends and social life they are less distracted from school work:

*"If anything, I'd say because the fatter, the people are isolated. They don't have the problems with friends, you know, to distract them. So, they're better*

*off, that way from school work. [...] It could, a lot of it, because they concentrate on their education. They bury their head in the book whereas others are all interested in make-up and all that. I think it's because they are not as interested in make-up, hair, friends. They actually getting their head down and doing their job, doing their job."* (Hanna's parent)

*"I feel Pamela is more studious because of her weight issue and I feel that she achieves more."* (Pamala's parent)

From the focus group and interview it emerged that parents also believe that performance in school is determined by pupils' personality and how much pupils are willing to commit to education. This was evident from the following two comments:

*"I think that is down to the individual, whether being fat, thin, you know. If they are up to put the work in then they will get there."* (Hannah' parent)

*"It's just the person, if you are willing to put the work in...This is what I believe. If people want to put the work in...Even an adult, a fat adult and a thin adult, it depends who wants to put the work in."* (Kirstin's carer)

## **D Role of weight management (Get Going)**

Obtaining insight into parents understanding of the role of a weight management programme like Get Going on children's school attainment and experiences was part of the second objective of this study. As shown in Figure 5.4, there were two lower level themes; benefits of Get Going and impact of weight management on school performance. These are described in detail below.

### **Benefits of Get Going**

This theme describes what parents perceive as the benefits of participating in Get Going for themselves and their daughters. It was evident that the parents believed that Get Going benefited them and their daughters in three aspects of life. These

aspects were clustered as the basic themes lifestyle, psychological well-being, and social life.

*Lifestyle.* Parents reported that Get Going had a positive effects on families' eating habits and parents stated that through the programme, their daughters learnt to make healthy food choices which they put into practice on a daily bases. For example, Pamela's parent described:

*"She goes 'No, I made a packed lunch and I made it healthy.' You know, she actually had made up coleslaw, no we had a pineapple. She chopped it all up and put pineapple chopped up in a tap like that."*

It emerged from the focus group and interview that increased fruit and vegetable intake and better awareness of fat content in food were benefits parents and the children gained from Get Going, as well as regular engagement in exercise: *"I mean, to be honest, as a parent, you know, it's great to see Hannah going out, going to the gym, going swimming, doing a lot more exercise and stuff like that."* (Hannah's parent)

*Psychological well-being.* Parents described that the biggest beneficial impact Get Going made was on youth's psychological well-being. Parents perceived that the improved psychological well-being benefited directly experiences in school. Parents reported that the programme was motivating and that their daughters gained confidence which helped them to cope with negative experiences in school. This is illustrated by the comment of Pamela's and Hannah's parents:

*"I feel it probably did give her more confidence. [...] She did get, she did cry and poured out her heart to one of the sort of year teachers, a man teacher she gets on with, to explain that there was a girl in her class. So, in a way I feel it gave her more confidence to speak up and actually get that situation dealt with."* (Pamela's parent)

*"This is where Get Going comes in. It gives them the confidence to go out..."* (Hannah's parent)

*Social life.* Meeting other families in Get Going was viewed as very positive for sharing experiences: “*And then it was good to meet all the other mothers, and all the other carers or parents of the children and whatnots and discuss how we handle things at home and that was quite nice.*” (Pamela’s parent) Parents perceived that the girls benefited most from meeting peers who are in a similar situation because through this the girls experienced acceptance, belonging and support to obtain a healthy lifestyle. This was evident in the following responses:

*“That is why the girls get along so well. Because they both know what each other is going through. And I think, that is exactly what it really is. That’s great for them to meet people that are alike.”* (Kirstin’s carer)

*“But then you see people that are like them. Which I think is good for them, that is great for them. It was quite exciting for her because she was getting accepted by the girls.”* (Margaret’s parent)

*“I find, obviously the girls are all the same age they do things, you know, which is good. They’re encouraging each other. [...] I think, the good thing that came out of it is, well Margaret likes the fact that she can keep in touch with the girls. If they do want to go they swap phone numbers that would be great.”* (Margaret’s parent)

### **Impact of weight management on school experience**

This theme relates to parents’ understanding and views of how a weight management programme like Get Going can benefit school experiences including school attainment of overweight youths.

Parents believed that a weight management programme can benefit school experiences and school attainment. However, they reported that to see actual changes it will take time and will not happen in the short term: “*But to actually to affecting her schooling and her personality, it’s far too early to say that. It’s a very positive start but it’s early days yet.*” (Hannah’s parent) Similarly, Pamela’s parent reported:

*“The thing is, what I find is, I don’t think we see the result while they’re doing the course. I think it’ll take time for it to sink in and then what we’ll learn will all be more constructive and it all will happen gradually. I don’t think it’s a quick fix.”*

## **5.4. Discussion**

The objectives of this study were to (i) gain insight into how overweight adolescents and their parents who participated in a weight management programme understand the association between youth obesity and educational attainment and what their body weight related school experiences are and (ii) to explore participants’ perception of the role of weight management to improve school experiences. To meet these objectives, focus groups and interviews were conducted and data analysed using thematic analysis.

Results suggest that both adolescent girls and parents/carers are aware of cardiometabolic health consequences and the negative impact of obesity on physiological well-being. Participants also reported negative psychological consequences of obesity, for example, low self-confidence and unhappiness due to body weight. Social consequences were also highlighted, for example, the girls reported difficulties being accepted and understood by normal weight peers in school, were generally not close to their classmates and were felt to be lacking friends.

Parents/carers believed that the girls’ body weight and the associated low self-confidence, friends and peer support are reasons for negative experiences within the school environment. From both adolescents’ and parents/carers’ responses, it emerged that the girls experience rejection by peers in school and that they are bullied and stigmatised by peers. Having a higher body weight than other teenagers in school was viewed by the girls as being a disadvantage during Physical Education (PE), for being accepted by classmates and getting appropriately sized clothes for school such as lab coats, school uniform, and PE kits. The girls reported that they experience negative body weight related comments, classmates laughing and

gossiping about them and that at times they feel isolated and ignored. Eating healthily in school and receiving support from classmates and other people in school to do so, was described as difficult and sometimes even a reason for being isolated from peers.

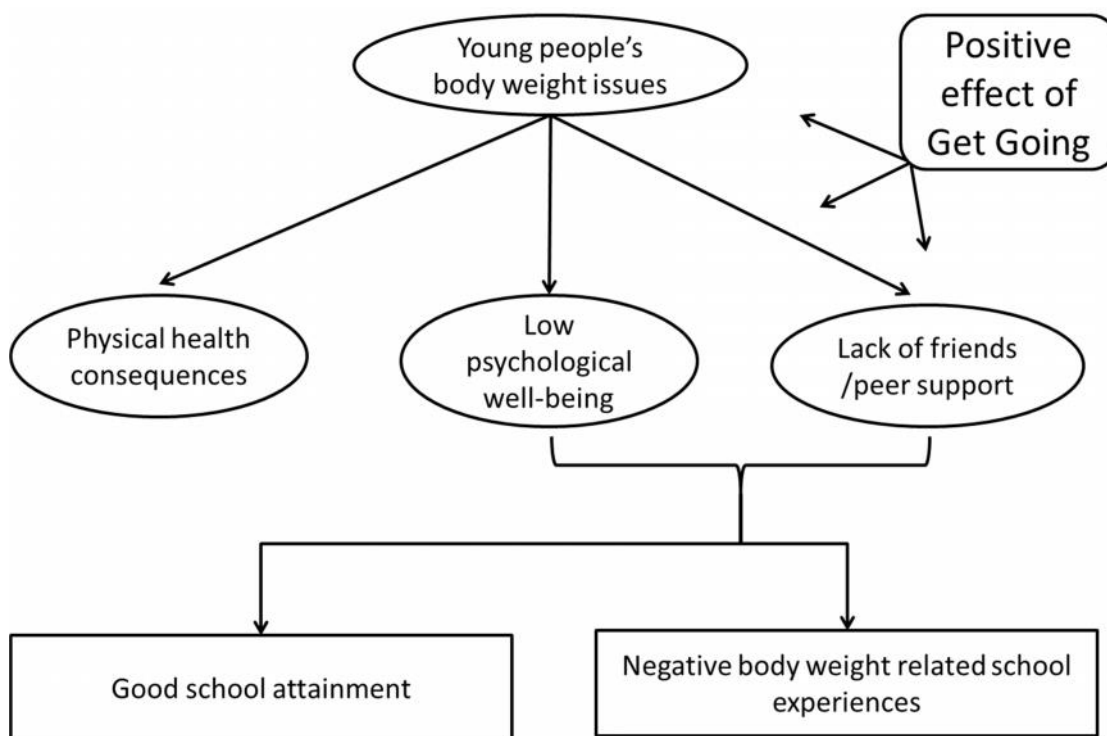
It was evident that, despite negative body weight related experiences in school, the girls have a positive attitude to education and school. They said that they do very well in school and sometimes even outperform normal weight classmates. The only subject the girls mentioned not to be good at is PE and this was perceived to be related to the girls' body weight. Parents and adolescents perceived that school performance is not necessarily related to body weight; school performance depends on pupils' attitude towards learning and efforts put into school work. However, participants believed that the reason for the girls' good school attainment is that they are less distracted from school work due to the lack of friends and good peer relationships. The girls said that having friends in class can lead to girls spending more time talking to their friends rather than concentrating and taking school seriously. Parents/carers perceived their daughters to have little interest in 'girly' things such as hair, make-up, and boys and that this allows them to focus on their education.

Participation in the weight management programme Get Going was viewed as very positive. Adolescents and parents/carers reported that Get Going encouraged them to make healthier lifestyle choices and that the girls gained confidence and felt happier about themselves. It was evident that meeting other families who are in a similar situation benefited the girls as they felt accepted, understood and motivated which they do not experience in school as frequently. Participants reported that taking part in Get Going gave the girls a sense of belonging. Improved self-confidence was also perceived as being important for the girls to stick up for themselves during incidences of bullying. The girls believed that taking part in a weight management programme like Get Going can only benefit school performance if the pupil has generally a negative attitude to school and a negative view on life. They felt that getting a positive attitude to life and gaining self-confidence and determination through a weight management programme can help to cope with other aspects in life. Parents/carers stated that a weight management programme like Get Going could



have beneficial effects on the girl's school experiences through improved self-confidence and peer support. However, parents described that it will take time to notice positive effects; they will not be seen in the short-term.

Figure 5.6 summarised how both adolescents and their parents understood the association between obesity and school performance and the role of weight management to improve school experiences.



**Figure 5.6: Flow diagram of the link between young peoples' body weight and school performance and the role of Get Going to influence school experiences**

The theme of overweight adolescents' relationship to peers in school has been identified previously in various studies. Researchers reported consistently findings on overweight youth being teased, bullied and socially rejected by peers which was related to their increased body weight status (Curtis, 2008; Davis & Davis, 2008; Economos et al., 2012; Fox & Edmunds, 2000; Holt et al., 2008; Lieberman et al., 2009; Lorentzen et al., 2012; Murtagh et al., 2006). Overweight children and adolescents also reported in previous studies that they find it difficult to make friends

and that they do not get on well with their classmates (Davis & Davis, 2008; Fox & Edmunds, 2000; Holt et al., 2008; Zeller et al., 2008). Consistent with findings of this study, previous literature indicated that PE is an environment where overweight youths seem to be exposed to negative body weight related comments (Curtis, 2008; Fox & Edmunds, 2000). The basic theme of eating in school relating to both, getting isolated from peers when choosing to eat healthy and feeling pressured to eat healthy because of being overweight also emerged in Curtis' (2008) study. For example, researchers indicated that study participants were subject to surveillance by peers when they consumed food. Eating healthy foods was viewed as confirming that overweight peers have issues with their body weight (Curtis, 2008).

Other themes that emerged during this study were participants' attitude to school and their performance in school in comparison to normal weight peers. Both themes are less well explored in the literature to date. Nevertheless, for the studies where these themes emerged, some consistencies were noted. Interviewed obese adolescents in Zeller et al.'s (2008) study said that they suffer from illness seldom and that they do not miss school often. Similar was described by the participants of this study. Zeller et al. (2008) and Fox and Edmund (2000) reported that their participants perceived that being overweight or obese is the reason for performing less well in PE (Fox & Edmunds, 2000; Zeller et al., 2008). In terms of comparing educational attainment between obese and normal weight pupils of other subjects than PE, two studies also indicated that obese youth do not perform worse than normal weight peers (Lorentzen et al., 2012; Zeller et al., 2008). Lorentzen et al. (2012) described that overweight pupils tend to help academically poor classmates with assignments in school which may suggest that they do perform better than some peers in school besides engaging in pro-social behaviour to form friendships. On the other hand, the study by Economos et al. (2012) suggested that the majority (75%) of overweight participants worried about doing well in school (Economos et al., 2012). However, more than 60% of the normal weight or underweight participants in this study also reported that they worry about their performance in school indicating that there might not be a difference in school performance between overweight or obese pupils and other peers.

Participants' perception of having a positive attitude to school and performing better or as good as normal weight children in school is in contrast with findings of quantitative observational literature reviewed in chapter 2. Findings from qualitative interview studies are, by nature, based on self-reported data from a smaller number of participants compared to quantitative cross-sectional or longitudinal studies (Ritchie et al., 2003). Therefore, findings of the present study and previous qualitative studies on the association between childhood obesity and educational attainment may generate biased conclusions when generalised for all overweight or obese children and adolescents. Moreover, quantitative research suggests that body weight related teasing, bullying and stigmatisation might mediate the relationship between childhood obesity and poor educational attainment (Puhl & King, 2013). Since participants of this study reported to perform well in school despite incidences of bullying and teasing, are in contrast with previous quantitative research.

However, the present study can help to understand the underlying mechanisms as to why some overweight children outperform normal weight children. Reasons for good school performance, despite negative body weight related experiences in school, were not explored in previous studies to date. Findings from focus groups and interviews of this study indicate that overweight adolescent girls perform better in school because they are less distracted from learning and doing homework due to lack of friends and interest in 'girly' things like fashion, make-up and boys. Focus on education rather than social contacts with peers might also be a coping mechanism for participants to avoid body weight related teasing, bullying and peer rejection. Similar results emerged from a participant response in the study by Curtis (2008). Performing well in school and getting rewarded for school work might be the only way in which the girls managed to feel accepted (by teachers) and capable of succeeding when being less successful in achieving a healthy body weight and close peer relationships. Furthermore, adolescents described that most teachers in school are non-judgmental against obese pupils and generally supportive, which might explain the positive attitude of the girls to school. In the literature it is reported that educational opportunities might be limited when teachers hold a biased perception about obese youths' academic abilities such as having poorer reasoning, social and physical and cooperation skills than normal weight peers (Puhl & King,

2013). This became evident from participants responses in relation to PE where the girls felt ignored and not supported by the teachers. Similar experiences were also reported by participants of Dixey et al.'s (2006) study. Their study participants also described that schools sometimes do not take responsibility against bullying but on another issue it was reported that other schools take this topic very serious (Dixey et al., 2006). Both views are consistent with comments made by the parents in this study.

However, it was evident from focus groups and interviews that getting rewarded for good performance in school seems not to be a sufficient substitute to deal emotionally with negative experiences in school and lack of friends and peer support. A weight management programme was viewed by participants as being helpful in gaining confidence, feeling better about themselves and building positive peer relationships. Participants' perspectives of other child weight management programmes confirmed beneficial effects on confidence, psychological well-being and peer relationships (Dixey et al., 2006; Murtagh et al., 2006; Pearson et al., 2012; Stewart et al., 2008). Participants of this study understood that these benefits can help coping with negative body weight related school experiences and potentially to improve school attainment. Indeed, these perspectives are consistent with literature demonstrating a positive relationship between subjective well-being and good mental health and educational attainment and school attendance (Suldo et al., 2011). Evidence from both quantitative observational studies and qualitative interview studies indicated that psychological well-being might be the mediating factor which influences the association between child and youth obesity and educational attainment (Caird et al., 2011). Although it was evident from focus groups and interviews that participants thought cardio-metabolic health can be improved through obtaining and maintenance of a healthy body weight status, participants did not perceive improved general health status as a factor that could be related to improved educational attainment. This might be because participants did not experience obesity-related ill-health which might have caused them missing school more often and thus having an academic disadvantage.

Therefore, findings of this study suggest that lifestyle interventions for weight management might benefit school experiences and indirectly benefit educational attainment by improving psychosocial well-being of participants.

#### **5.4.1. Strengths and Limitations**

Previous research has emphasised the value of obtaining insight into the perspectives and experiences of overweight children and adolescents and their parents in general or in relation to weight management programmes in particular. Only a few studies have explored how overweight children and adolescents perceive the school environment. This study was the first study that explored, from the participants' perspective, how lifestyle interventions for weight management can beneficially impact on educational attainment/school experiences and how this relates to body weight related school experiences. Both views and experiences from adolescents and their parents/carers were collected to gain a comprehensive understanding of the association between childhood obesity and school experiences/educational attainment. Despite the small number of participants within this study, rich explorative data was obtained. Reliability of findings was increased by employing independent coding by two researchers (AN and myself). Codes were cross-checked and agreement achieved through discussions where needed. External validity of findings was ensured by involving participants in the data analysis process by asking for consistency between what they have said during the focus groups/interviews and what the identified themes relate too.

Nevertheless, this study has some limitations which may impact on the generalizability of the findings. First, data collected through different means were combined for analysis due to practicalities of the study conducted. However, both focus groups and interviews were suitable to collect data for this study. Since this study involved talking about sensitive topics it was important that participants could choose whether they wanted to take part in group discussions or individual interviews. Participants who decided to take part in the focus groups already knew each other from being in the same weight management group. Therefore, both adolescents and parents might have felt more comfortable sharing their experiences

and views, as they were in the company of familiar people. The opportunity to participate in individual interviews might have advantages for participants that were not close to other Get Going members and preferred to talk about sensitive topics in private. Since the sampling strategy for this study was guided by participation in the weight management programme Get Going (criterion sampling approach) and both methods of data collection appeared to be suitable for the purpose of this study it was considered to be acceptable to collate the data in the analysis.

Second, participant responses were likely to be influenced by the different data collection methods as well as by the characteristics of the interviewer (me). Responses of focus group participants might have been influenced by answers and reactions from other group members and by the group dynamic; however this is generally the purpose for conducting focus groups. Group discussions should encourage participants to express opposing opinions, to refine their views and to develop common ideas (Finch & Lewis, 2003). Reflecting on the discussion atmosphere of both focus groups (adolescents and parents/carers), all participants had the opportunity to express their views and experiences equally and all responses were respected. Agreement on 'ground rules' prior to the focus groups helped to ensure a comfortable discussion environment. Although during individual interviews participant responses were not influenced by other group members, verbal and non-verbal interviewer responses might have affected participants' answers. For both focus groups and interviews, I aimed to be as neutral as possible whereby expressing sympathy and interest for participants' experiences. Nevertheless, answers from participants and willingness to participate in the first place might have been influenced simply by the fact that this was a University based study, i.e. conducted by people from a higher education background. Moreover, answers were possibly affected, either positively or negatively, by the interviewer's characteristics such as body weight status (not overweight/obese), gender (female), age (older than adolescents and younger than parents), nationality (German), level of expertise (student researcher) and not being a parent. To overcome potential barriers, I aimed to establish a good rapport with the participants.

Third, study findings are based on the responses of four youth and four parents/carers. Although qualitative studies do not require a large sample size to

generate meaningful and insightful outcomes (Ritchie et al., 2003), the sample size of this study might have been too small to reach saturation of themes (i.e. when new data do not add anything new to themes or the overall model). Data/theme saturation is commonly used as a quality criteria of an adequate sample size (O'Reilly & Parker, 2013). Sample sizes of previous interview/focus group studies related to childhood obesity and referred to in this chapter ranged from 4 to 30 children and 6 to 21 parents. However, none of the studies reported whether their sample size was sufficient to reach saturation of themes. In the literature, there is no agreement of how many individual participants or focus groups are required to achieve saturation (Mason, 2010). Thematic saturation might be reached with fewer participants when the study aim targets a specific population group on a concise topic (Mason, 2010). However, there is a debate regarding whether saturation should be used as a criterion to determine number of participants (O'Reilly & Parker, 2013). Research suggests that sample size in qualitative research should be determined by richness of participants' views and perceptions and its ability to answer the research question (O'Reilly & Parker, 2013). Since the aim of this study was of an explorative nature, the sample size of this study may be adequate, at least to provide initial insights.

Fourth, although aimed at including both girls' and boys' perspectives, study findings of youth were obtained from girls only. Therefore, findings should not be related to experiences and perceptions of overweight or obese boys because they might experience the association between obesity and school attainment differently.

Finally, ethical reasons allowed recruitment of only those participants who had completed the weight management programme. One might assume that participants who managed to complete the intervention have generally a positive attitude to the intervention, which might be reflected in their discussion/interview responses. Answers and subsequently study results may differ when perceptions and experiences of participants are obtained who did not complete the intervention or were not referred to a weight management programme at all. For example, these participants may not experience benefits on self-confidence and peer support which in turn might not be viewed as a potential factor to impact on school experiences and attainment positively.

In summary, strengths of this study were that findings were generated using methods to increase reliability and validity of the results. Great attention and careful consideration of the focus group/interview context was given to ensure a relaxed and comfortable environment while talking about a sensitive topic. Findings also provide rich initial insight into both adolescents and their parents perspectives and experiences. However, the generalizability of findings to other overweight or obese adolescents and their parents is likely to be limited due to a low number of adolescent girls and their parents/carers who all completed the weight management programme.

#### **5.4.2. Implications for practice and research**

Findings of this study suggest that improved psychological well-being and peer support through participation in a weight management programme might benefit school experiences and, indirectly, educational attainment of overweight adolescent girls. Therefore, primary care weight management interventions should emphasise on strengthening confidence, motivation and determination and establishing peer support of female participants. This may not only benefit healthy lifestyle changes but may also promote positive experiences in school. However, due to methodological shortcomings and limited generalisation, implications for practice should be considered carefully.

Study findings may inform future research in terms of developing effective interview guides for exploring addressed topics in more depth. Future research should include experiences and perspective of boys as well as younger participants. Since participants of this study were recruited from a single weight management programme, future research should explore participant's perceptions of the role of other weight management programmes for improving school experiences and attainment. Research and practice may also benefit from applying a longitudinal approach, where participants are interviewed before and after taking part in the intervention. Future research may want to explore which specific aspects of the programme incurred the greatest benefits; whether, for example, it was the programme itself or the relationships formed during the programme that lead to



better outcomes. This is likely to assist in making recommendations for future weight management programmes to be most effective.

## **5.5. Conclusion**

Overweight adolescent girls and their parents perceived no direct connection between body weight status and educational attainment. They understood that educational attainment depends on pupils' attitude to education and school, regardless of their body weight. Within the school environment, overweight participants reported to be exposed to body weight related isolation, peer rejection, stigmatisation, and bullying, which led to low self-confidence and being unhappy. This was confirmed by the parents/carers of the adolescent participants. It emerged that an intervention for overweight or obese children and adolescents can have a considerate impact on participants' psychological and emotional well-being. The intervention also provided a great opportunity for the children to experience peer support and a sense of belonging. These benefits of a weight management programme were viewed to be the mediating factor to explain how lifestyle interventions for weight management could benefit school experiences and school attainment.

Therefore, besides educating on healthy eating and physical activity habits, lifestyle interventions for weight management could focus on improving participants' psychosocial well-being, as this may have potential benefits on a healthy lifestyle and may improve school experiences, including educational attainment. Since study findings relate to adolescent girls and their parents only, this implication might only be limited to adolescent girls, thus future research should explore the perspective and experiences of overweight boys and younger (primary school aged) children of both genders.

## **Summary: Body weight and school experiences: Perception and beliefs of children and their parents**

### ***Findings***

- Overweight adolescent girls reported low self-confidence, sadness and a lack of friends, while in school they were exposed to body weight related isolation, peer rejection, teasing and bullying
- Despite negative experiences in school, adolescents reported a positive attitude towards some aspects of school, for example, they took their education seriously and performed well academically
- It was perceived that a lack of friends in class may help to become less distracted from learning
- Emphasis on education might be a coping mechanism to avoid bullying and peer rejections
- Participation in Get Going can benefit pupils' self-confidence and emotional well-being and gives a sense of belonging which might help adolescents to cope with negative body weight related experiences in school; this indirectly may impact positively on school performance
- Participation in Get Going was not perceived to directly influence school attainment

### ***Implication for research:***

- Future research should explore perceptions of younger children, boys and participants taking part in other weight management programmes
- Parents' comments suggest that longitudinal effects might occur and thus there might be a need for a prospective assessment and longer follow-up of weight management studies

### ***Implication for practice:***

- Findings suggest that primary care weight management interventions should consider strengthening confidence, motivation and establishing peer support, to not only benefit healthy lifestyle changes but also to promote positive psychological and social development and positive experiences in school

## **CHAPTER 6 – Discussion & Conclusion**

The aim of this thesis was to assess the effect of lifestyle interventions on educational attainment in overweight and obese children and adolescents. The rationale for conducting this research stems from findings of the systematic review on the association between childhood obesity and educational attainment (Chapter 2) which suggest that overweight and obese children and adolescents typically perform less well in school than normal weight peers. Findings also indicate that this association might be mediated by factors such as cognitive abilities, cardio-metabolic ill-health, disordered sleep, psychosocial distress, low levels of physical activity, and unhealthy diet. Increased physical activity, reduced sedentary behaviour (sitting time) and a healthy diet are clinically recommended interventions for paediatric weight management. These interventions were shown to benefit cognitive and educational abilities in normal weight children. Earlier in this thesis I reviewed plausible mechanisms to explain how these interventions may also benefit overweight and obese children.

### **6.1. Summary of findings**

Using a mixed method approach, three studies were carried out to address the aim of this thesis. First, I conducted a systematic literature review and meta-analysis of randomised controlled trials (RCTs) to assess the efficacy of lifestyle interventions on educational attainment and associated abilities and achievements. Findings suggest that a school-based healthy lifestyle education combined with nutrition interventions can produce small improvements in overall school attainment. Furthermore, a single component after-school physical activity intervention produced small improvements in mathematics attainment, executive function, and working memory. There was no evidence of an effect of any lifestyle intervention on reading, vocabulary and language attainment, attention, inhibitory control, and simultaneous processing. Existing studies showed a range of methodological issues affecting the quality of evidence.

Since all studies included in the systematic review of RCTs were conducted in a school-based setting, I aimed to evaluate the effect of lifestyle interventions for weight management on educational attainment in a primary care setting. Linking data from a Scottish primary care weight management service (POST) with education data from local education authorities, allowed an opportunity to evaluate the feasibility of exploring the effectiveness of lifestyle interventions on educational attainment of overweight and obese children. Findings indicate that cross-sectorial ad hoc data-linkage is legally, ethically, and technically feasible to be implemented in a definitive study. Although not the primary aim of the study, available pilot data showed no evidence of a beneficial effect of a primary care child weight management programme on reading, writing and mathematics attainment in overweight and obese children. No evidence of a beneficial effect of the intervention on educational attainment could be explained by a number of factors. For example, data related issues (e.g. poor quality of administrative data and/or unassessed potentially relevant mediating factors), quality of intervention (e.g. no active physical activity component, intensity of intervention) or lack of transfer (e.g. POST, though effective for reduction in BMI-SDS, does not produce significant changes to educational attainment).

Secondary data analysis of the first two studies showed a lack of available data to assess mechanisms for how lifestyle interventions for weight management can benefit educational attainment in overweight and obese children. Since evidence from previous observational research suggested an influential role of mediating factors (Caird et al., 2011), I conducted a focus group/interview study to obtain an understanding of how participants who have completed a weight management programme, view the obesity-attainment association and the role of weight management programmes for improving school performance. It emerged that performance in school for all subjects but Physical Education was understood to be determined by pupils' attitude to school and not body weight status per se. Being overweight or obese was viewed, by the eight participants of study 3, as a reason to be exposed to teasing, bullying, isolation and peer rejection within the school environment. Interviewed adolescent girls and their parents perceived that the lack of friends in class helps them to be less distracted from learning. Participation in weight

management programmes can benefit pupils' self-confidence, determination and emotional well-being and gives a sense of belonging as evident from study 3 and previous literature. This might help to cope with negative body weight related experiences in school and thus indirectly impact positively on educational attainment for pupils with a negative attitude to learning.

Better educational attainment due to increased body weight was an unexpected finding, given the large body of literature indicating that overweight or obese children tend to underperform in school. This finding highlights the complex relationship between childhood obesity and educational attainment. There may be some factors, more prevalent among overweight or obese children, which make them more likely to perform less well in school compared to normal weight peers (e.g. greater school absence, health issues, lower self-esteem). However, there may be some other factors may make overweight and obese more likely to perform better in school than normal weight peers (e.g. less distracted by friendship groups, more emphasis on academic activities than social activities).

## **6.2. Importance of the research**

The findings of this doctoral research contribute to the development of knowledge through providing evidence of the efficacy of randomised controlled lifestyle interventions on educational attainment and cognitive function in overweight and obese children and adolescents. To date, little is known about the effectiveness of weight management programmes, employing lifestyle interventions, on educational attainment. This might be related to a strong emphasis on reducing the risk of physical co-morbidities (e.g. cardiometabolic diseases) as the primary aim of childhood weight management programmes, rather than cognitive and educational outcomes. Moreover, health policy makers and practitioners might be unaware of the negative association between child obesity and educational attainment and potential benefits of weight management programmes on these outcomes. Findings of this research provide evidence on the feasibility of exploring the effectiveness of child weight management interventions on educational attainment in Scotland using a cross-sectorial data-linkage approach. However, it also highlighted a number of challenges. Previous research on cognitive or educational outcomes using cross-

sectorial data linkage methods has not linked primary care childhood weight management data. An additional aspect of this doctoral research (study 3) helped to gain an understanding of potential mechanisms to explain how lifestyle interventions for weight management may benefit educational attainment in overweight and obese children and adolescents. Previous studies assessing the efficacy of lifestyle interventions for improving cognitive function and educational attainment (Ahamed et al., 2007; Davis et al., 2011; Johnston et al., 2013; Staiano et al., 2012; Winter & Sass, 2011; Wirt et al., 2013) did not obtain the perspectives of the study participants. In contrast, this research gave a voice to overweight and obese adolescents and their parents who participated in a lifestyle intervention for weight management.

Collectively, the conducted research studies and its findings are important as they contribute to the development of effective long-term interventions in accordance with the final stage of the MRC framework for complex interventions (Campbell et al., 2000). This research explored, to some extent, the first four stages of the MRC framework. Chapter 2 evaluated the theory on the association between childhood obesity and educational attainment and how lifestyle interventions could work for improving cognitive and educational outcomes (Stage 1). Findings of study three may help to model determinants of the intervention effect (Stage 2). Study two and three followed an explorative approach to test the effectiveness of weight management interventions on educational attainment (stage 3/4). Finally, evidence from the Cochrane review (study 1) provided an explanation for the efficacy of lifestyle interventions in overweight and obese children and adolescents for improvement of educational attainment and cognitive function (Stage 4).

The present research findings also identified areas of research that may need further investigation in the future to develop our understanding of: to what extent and in what way, lifestyle interventions can improve educational attainment and associated cognitive function in overweight and obese children. Therefore research findings may influence future generations of research. The section 'Implications for future research' below outlines some aspects that could be explored subsequently.

### 6.3. Strengths and limitations

The strength of the presented research is that a high-quality methodological approach in form of Cochrane systematic review and meta-analysis was applied to evaluate the effect of lifestyle interventions on educational attainment and cognitive function. The systematic review presented in Chapter 3 has been peer reviewed internally and externally by the Cochrane Collaboration. Furthermore, a mixed methods approach was used, comprising quantitative secondary data analyses (study 1 and 2) and qualitative primary research (study 3). The mixed methods approach allowed both methodological inquiries to complement each other. Study 1 and 2 were lacking of data to assess mechanisms which could be obtained employing qualitative data collection methods. Evidence from reviewed quantitative studies suggested that, among other factors, psychosocial and emotional well-being might be a mediator in the causal pathway between childhood obesity treatment and improved educational attainment. Perceptions and understanding of overweight participants of a lifestyle intervention for weight management further suggested that psychosocial well-being plays an important role in improving school experiences and attainment. Qualitative data of this doctoral research also added breadth to the understanding of the childhood obesity-attainment association as they provided insight into consequences and coping strategies of body weight related negative experiences in school in connection to school performance.

A common limitation for the thesis studies (Chapter 3 to 5) was a small sample size (and number of included studies in the Cochrane Review). Small sample sizes result in reduced validity and generalizability of research findings. Although the prevalence of childhood obesity is high in Scotland and most developed countries, overweight and obese children are a special population group and related research appears to be challenging. Firstly, due to ethical issues around the identification of overweight and obese study participants, difficulties arise for recruitment into studies. Secondly, lifestyle interventions require participants' behaviour change and readiness to change. Lack of motivation to change lifestyle behaviour may influence participation

in interventions for overweight and obese children (Grow et al., 2013; Reinehr, 2013; Taylor et al., 2013). Thirdly, research indicated that a lack of awareness and concerns regarding childhood obesity also influenced interest to participate in treatment programmes negatively (Dhingra et al., 2011; Taveras et al., 2011; Taylor et al., 2013). Therefore sample sizes might be generally lower from the onset. This was evident, for example, in the systematic review on the effect of lifestyle interventions for treatment of childhood obesity where only 10 out of 64 included studies randomised more than 100 participants and 32 of all included studies had a sample size of less than 50 (Oude Luttikhuis et al., 2009). Additionally, lifestyle interventions for both research and primary care are associated with high attrition rates, leading to restricted availability of post-treatment measurements, which will reduce the number of participants in the analytic sample and representativeness of the final sample. Systematic review evidence indicated that attrition rates immediately after interventions ranged from 0% to 42% (Oude Luttikhuis et al., 2009) and from 5% to 46% (Wilfley et al., 2007) with an average attrition of 20%. Perceived benefits of the intervention, unmet expectations, scheduling conflicts and financial barriers (e.g. money for transportation to the intervention) are commonly reported reasons for discontinuation of weight management programmes (Grow et al., 2013; Idalski Carcone et al., 2011; Sallinen et al., 2013).

The majority of findings of this doctoral research were generated from secondary data analyses. Relying on data collected for other purposes than this thesis resulted in a lack of quality and availability of potentially relevant data needed to assess the effect of lifestyle interventions on educational attainment in overweight children. As mentioned earlier, data available for study 1 and 2 did not allow exploration of mediating factors. However, use of existing data is a practical and cost effective approach to produce explorative and definite answers to novel research questions. Hence, research councils recommend and support the analysis of previously collected data. Furthermore, collating intervention effects from various studies in a meta-analysis (i.e. secondary data analysis) was shown to generate a more precise estimate of the effect of an intervention than the effect of a single study (Glass, 1976).



In addition to the small sample sizes, findings from the presented research may not be applicable to other settings (e.g. developing countries). Although study 1 employed an international focus, evidence on the effect of lifestyle interventions was available from developed countries only and additionally interventions were conducted in the school context. Feasibility of data linkage and effectiveness of a primary care weight management programme on educational attainment was assessed within the Scottish context using local data sharing policies and data from a local weight management programme (POST in Tayside) and the Scottish education system. Similarly, perspectives of overweight youth and their parents were also obtained from another local weight management programme in Scotland (Get Going in Edinburgh) which limits the generalizability of the findings to participants of other weight management programmes in Scotland and other countries. Moreover, results of study 3 focused on adolescent girls who had continued to the end of a weight management programme. The perceptions and experiences might vary for younger participants, boys, and adolescents who do not choose to opt in to a weight management programme or who choose to discontinue the programme before completion. However, Get Going was implemented following current clinical guideline in the UK (NICE, 2013; SIGN, 2010) and therefore findings might be applicable to adolescent girls who completed other weight management programmes within the UK.

To conclude, this research provided important and useful initial insights into aspects of lifestyle interventions for improving educational attainment in overweight and obese children and adolescents and highlighted areas for future research.

## **6.4. Implications for future research**

Overall, there is a need for well-designed randomised controlled lifestyle intervention trials for overweight and obese children which focus on educational attainment and/or cognitive function outcomes, to evaluate the efficacy of lifestyle interventions on these outcomes. Future childhood obesity treatment trials in both

clinical and school settings should consider including educational attainment and cognitive outcomes with long-term follow-up measurements. Particularly, evidence on the effect of the lifestyle intervention components healthy diet, behaviour change techniques, and reduced sedentary behaviour is needed. Low cognitive abilities may be associated with behaviours that cause obesity (reverse causation); therefore identifying which components of lifestyle interventions benefit specific cognitive domains could optimise both the physical and cognitive outcomes of obesity treatment programmes.

Obtaining perceptions and attitudes of intervention participants is important and should be considered in future research to allow an evaluation of the intervention and to explore potential mechanisms needed to inform long term implementation. This should to be done for intervention programmes in various settings (e.g. school based, primary care, high/middle/low income countries, rural/urban) including boys and girls from different age groups. To inform mechanisms and subsequent effectiveness of the intervention, additional objective data related to potential mediating factors (e.g. cardio-metabolic markers, psychological well-being and neurocognitive function) should be obtained and related to the intervention effect on educational attainment and cognitive function.

In terms of the use of administrative data to assess the effectiveness of weight management programmes on educational attainment in Scotland, future research should link data from sources at a national level to ensure sufficient statistical power using established data linkage systems. Linkage of objectively obtained and reliable outcome data is important and needs to be considered in future studies. Furthermore, child healthy weight intervention and education data could be linked with additional health records and/or survey data to obtain information on potential confounding and mediating variables which might strengthen the confidence that changes in educational attainment are due to the intervention.

## **6.5. Implications for practice**

Although RCTs have shown that the effect of lifestyle interventions on educational attainment, executive function and memory are small, a very large number of

children and adolescents could benefit from these interventions given the high prevalence of child and youth obesity. Therefore health policy makers may wish to consider these potential additional benefits when promoting physical activity and healthy eating in schools.

Although based on responses of four families only, weight management programmes may benefit educational experience and attainment through improvement of children's psychosocial well-being. Therefore, primary care weight management interventions may want to emphasise strengthening confidence, motivation and determination and establishing peer support of female participants, in addition to educating on behaviour change for healthy eating, increased physical activity and reduced sedentary behaviour.

Participants' awareness of a further beneficial outcome of a child weight management programme such as improved educational experiences and attainment might enhance the response to and uptake of lifestyle interventions for childhood weight management. It was shown that completion rates of paediatric weight loss programmes are low (Oude Luttikhuis et al., 2009; Wilfley et al., 2007). Awareness of improved educational attainment could potentially be an additional intrinsic motivational element for children and parents to attend and complete a weight management programme. It emerged from previous research that lifestyle interventions for weight management work best when children take the ownership of their behaviour change (Lieberman et al., 2009; Lorentzen et al., 2012; Tyler & Horner, 2008) after being encouraged by their parents who take a strong position as role model (Boutelle et al., 2012; Pearson et al., 2012; Tyler & Horner, 2008). Greater weight loss and long-term maintenance was achieved in a weight management intervention where the improvement of health has been the focus rather than external attractiveness (Vansteenkiste et al., 2007). Furthermore, parents seem not to view excessive body fat as reason for concern unless someone has functional impairment and health consequences (Burnet et al., 2008; Goodell et al., 2008). Researchers concluded that parents might respond better to lifestyle change interventions when the focus lies on improvement of their child's health rather than

weight loss. Therefore, it appears plausible that the awareness of other potentially beneficial outcomes (e.g., improved psychological wellbeing, educational experiences and attainment) of lifestyle interventions for weight management could also encourage families with overweight children to engage and complete interventions. This in turn could also benefit health outcomes since premature attrition from weight management programmes was associated with lower body mass index standard deviation score (BMI-SDS) reduction (Denzler et al., 2004).

Based on this doctoral research it emerged that there is a need for improved recording of routine administrative weight management and education data using standard protocols in Scotland. This is important not only for potential access for research, but also for a comprehensive evaluation of current services, where results might influence interventions and policy implementations. To ensure adequate support and supervision of children, particularly of children at risk for disadvantaged development, routine data-sharing between the health and education sector is required.

In summary, findings on the efficacy of lifestyle interventions for improvement of cognitive function and educational attainment could be used to inform school-based health policies. In addition to the efficacy findings, evidence from youths' and parents' interviews might be used to encourage families with overweight children to attend and complete weight management programmes which employ lifestyle interventions. Findings from the data-linkage study indicate that existing child weight management programmes and schools in Scotland need to improve recording of administrative data and that systems for routine data-sharing should be put in place.

## **6.6. Conclusion**

Child health and educational attainment are, to some extent, related; research illustrated that childhood obesity is associated with lower school achievement and related cognitive functions. Childhood obesity is highly prevalent worldwide and lifestyle interventions targeting healthy eating, increased physical activity and

decreased sedentary behaviour using behaviour change techniques are recommended for treatment and prevention of childhood obesity. There is an emerging area of research investigating the effect of lifestyle interventions on educational attainment and cognitive function in overweight and obese children and adolescents.

Systematic review evidence that emerged from this doctoral research indicates that school-based healthy lifestyle education combined with nutrition interventions can produce small improvements in overall school attainment and that a single component after-school physical activity intervention can improve mathematics attainment, executive function, and working memory in overweight and obese children. After it is shown that lifestyle interventions can work (assessed efficacy), there is a need to evaluate the effectiveness of the interventions in a real-world setting. This research established that it is feasible to evaluate the effectiveness of lifestyle interventions for child weight management using administrative data when the quality of data recording is improved and reliable data items accessed. Explorative focus group and interview data from overweight adolescents and their parents who participated in a weight management programme indicated that psychosocial benefits of child weight management programmes might be the mediating factor of improved educational experiences and subsequent educational attainment in overweight and obese children and adolescents.

Generalizability of all research findings is limited since the evidence is based on a small study population in a specific environment (school based or Scottish primary care weight management). Additionally, findings should be interpreted with caution given underlying methodological shortcomings. Therefore, there is a need for further research on the efficacy of lifestyle interventions in other settings on educational and cognitive achievements, on the short and long-term effectiveness of the lifestyle interventions for improving educational attainment and on mechanisms of how lifestyle interventions may impact beneficially on educational attainment and cognitive function in overweight and obese children and adolescents.

Given the high prevalence of childhood obesity, educational and cognitive outcomes of a high number of children could be improved through increased physical activity and nutrition education. Health policy makers may wish to consider these potential additional benefits when promoting physical activity and healthy

eating in schools. Primary care child weight management programmes may want to promote psychosocial well-being of participants, improve routine data recording and obtain participants' administrative education data from schools or local authorities, to ensure adequate support and supervision of this vulnerable population group of overweight and obese children and adolescents.

## 7. References

- Abdelalim, A., Ajaj, N., Al-Tmimy, A., Alyousefi, M., Al-Rashaidan, S., Hammoud, M. S., et al. (2012). Childhood obesity and academic achievement among male students in public primary schools in Kuwait. *Medical Principles and Practice*, 21(1), 14-19. doi: <http://dx.doi.org/10.1159/000331792>
- Ahamed, Y., Macdonald, H., Reed, K., Naylor, P. J., Liu-Ambrose, T., & McKay, H. (2007). School-based physical activity does not compromise children's academic performance. *Med Sci Sports Exerc*, 39(2), 371-376. doi: 10.1249/01.mss.0000241654.45500.8e  
00005768-200702000-00021 [pii]
- Ali, M. M., Rizzo, J. A., & Heiland, F. W. (2013). Big and beautiful? Evidence of racial differences in the perceived attractiveness of obese females. *J Adolesc*, 36(3), 539-549. doi: 10.1016/j.adolescence.2013.03.010
- Anderson, J. W., Johnstone, B. M., & Remley, D. T. (1999). Breast-feeding and cognitive development: a meta-analysis. *Am J Clin Nutr*, 70(4), 525-535.
- Averett, S. L., & Stifel, D. C. (2010). Race and gender differences in the cognitive effects of childhood overweight. *Applied Economics Letters*, 17(17), 1673-1679. doi: 10.1080/13504850903251256
- Baker, D. P., Salinas, D., & Eslinger, P. J. (2012). An envisioned bridge: schooling as a neurocognitive developmental institution. *Dev Cogn Neurosci*, 2 Suppl 1, S6-17. doi: S1878-9293(11)00134-4 [pii]  
10.1016/j.dcn.2011.12.001
- Barone, A., & O'Higgins, N. (2010). Fat and out in Salerno and its province: Adolescent obesity and early school leaving in Southern Italy. *Economics & Human Biology*, 8(1), 44-57. doi: 10.1016/j.ehb.2009.09.003
- Barrigas, C., & Fragoso, I. (2012). Obesity, academic performance and reasoning ability in Portuguese students between 6 and 12 years old. *Journal of biosocial science*, 44(2), 165-179. doi: <http://dx.doi.org/10.1017/S0021932011000538>
- Bartholomew, J. B., & Jowers, E. M. (2011). Physically active academic lessons in elementary children. *Preventive Medicine*, 52 Suppl 1, S51-54. doi: S0091-7435(11)00045-4 [pii]  
10.1016/j.ypmed.2011.01.017
- Bartholomew, L. K., Parcel, G. S., Kok, G., Gottlieb, N. H., & Fernandez, M. E. (2011). *Planning health promotion programs: an intervention mapping approach* (3rd ed.). San Francisco: Jossey-Bass.
- Baxter, S. D., Guinn, C. H., Tebbs, J. M., & Royer, J. A. (2013). There Is No Relationship between Academic Achievement and Body Mass Index among Fourth-Grade, Predominantly African-American Children. *Journal of the Academy of Nutrition and Dietetics*, 113(4), 551-557.
- Baxter, S. D., Royer, J. A., Hardin, J. W., Guinn, C. H., & Devlin, C. M. (2011). The relationship of school absenteeism with body mass index, academic achievement, and socioeconomic status among fourth-grade children. *J Sch Health*, 81(7), 417-423. doi: 10.1111/j.1746-1561.2011.00610.x
- Beebe, D. W., Ris, M. D., Kramer, M. E., Long, E., Amin, R., Beebe, D. W., et al. (2010). The association between sleep disordered breathing, academic grades,

- and cognitive and behavioral functioning among overweight subjects during middle to late childhood. *Sleep*, 33(11), 1447-1456.
- Belot, M., & James, J. (2011). Healthy school meals and educational outcomes. *Journal of Health Economics*, 30(3), 489-504. doi: <http://dx.doi.org/10.1016/j.jhealeco.2011.02.003>
- Belsky, D. W., Caspi, A., Goldman-Mellor, S., Meier, M. H., Ramrakha, S., Poulton, R., et al. (2013). Is Obesity Associated With a Decline in Intelligence Quotient During the First Half of the Life Course? *Am J Epidemiol*. doi: 10.1093/aje/kwt135
- Best, J. R., Miller, P. H., & Jones, L. L. (2009). Executive Functions after Age 5: Changes and Correlates. *Dev Rev*, 29(3), 180-200. doi: 10.1016/j.dr.2009.05.002
- Beyerlein, A., Toschke, A. M., & von Kries, R. (2010). Risk factors for childhood overweight: shift of the mean body mass index and shift of the upper percentiles: results from a cross-sectional study. *Int J Obes (Lond)*, 34(4), 642-648. doi: 10.1038/ijo.2009.301
- BHFNC. (2011). UK Physical Activity Guidelines for Early Years (walkers) Retrieved 21 January 2014, from <http://www.bhfactive.org.uk/userfiles/Documents/guidelineswalkers.pdf>
- Bisset, S., Fournier, M., Pagani, L., & Janosz, M. (2013). Predicting academic and cognitive outcomes from weight status trajectories during childhood. *Int J Obes (Lond)*, 37(1), 154-159. doi: 10.1038/ijo.2012.106
- Booth, J. N., Tomporowski, P. D., Boyle, J. M. E., Ness, A. R., Joinson, C., Leary, S. D., et al. (2014). Obesity impairs academic attainment in adolescence: findings from ALSPAC, a UK cohort. *International Journal of Obesity, accepted article preview*.
- Borys, J. M., Le Bodo, Y., Jebb, S. A., Seidell, J. C., Summerbell, C., Richard, D., et al. (2012). EPODE approach for childhood obesity prevention: methods, progress and international development. *Obes Rev*, 13(4), 299-315. doi: 10.1111/j.1467-789X.2011.00950.x
- Boutelle, K. N., Feldman, S., & Neumark-Sztainer, D. (2012). Parenting an overweight or obese teen: issues and advice from parents. *J Nutr Educ Behav*, 44(6), 500-506. doi: 10.1016/j.jneb.2011.12.005
- Boyd, B. (2008). The Structure of the Secondary Curriculum. In T. Bryce & W. Humes (Eds.), *Scottish Education Beyond Devolution* (3rd ed., pp. 425-434). Edinburgh: Edinburgh University Press.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3, 77-101.
- Brixval, C. S., Rayce, S. L., Rasmussen, M., Holstein, B. E., & Due, P. (2011). Overweight, body image and bullying--an epidemiological study of 11- to 15-years olds. *Eur J Public Health, [Epub ahead of print]*. doi: ckr010 [pii] 10.1093/eurpub/ckr010
- Bromley, C., Dowling, S., Gray, L., Hinchliffe, S., Hughes, T., Leyland, A., et al. (2013). The Scottish Health Survey. In L. Rutherford, S. Hinchliffe & C. Sharp (Eds.), *2012 Edition* (Vol. 1 pp. 187-197). Edinburgh: The Scottish Government.
- Brozek, J., Oxman, A., & Schünemann, H. (2008). GRADEpro (Version 3.2 for Windows).



- Bruce, A. S., Martin, L. E., & Savage, C. R. (2011). Neural correlates of pediatric obesity. *Prev Med*, 52 Suppl, S29-35. doi: S0091-7435(11)00046-6 [pii] 10.1016/j.ypmed.2011.01.018
- Bryce, T. (2008). Assessment in Scottish Schools. In T. Bryce & W. Humes (Eds.), *Scottish Education Beyond Devolution* (3rd ed., pp. 581-594). Edinburgh: Edinburgh University Press.
- Burnet, D. L., Plaut, A. J., Ossowski, K., Ahmad, A., Quinn, M. T., Radovick, S., et al. (2008). Community and family perspectives on addressing overweight in urban, African-American youth. *J Gen Intern Med*, 23(2), 175-179. doi: 10.1007/s11606-007-0469-9
- Caird, J., Kavanagh, J., Oliver, K., Oliver, S., O'Mara, A., Stansfield, C., et al. (2011). Childhood obesity and educational attainment: a systematic review. London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London.
- Calcaterra, V., Klersy, C., Muratori, T., Telli, S., Caramagna, C., Scaglia, F., et al. (2008). Prevalence of metabolic syndrome (MS) in children and adolescents with varying degrees of obesity. *Clin Endocrinol (Oxf)*, 68(6), 868-872.
- Campbell, M., Fitzpatrick, R., Haines, A., Kinmonth, A. L., Sandercock, P., Spiegelhalter, D., et al. (2000). Framework for design and evaluation of complex interventions to improve health. *BMJ*, 321(7262), 694-696.
- Cappuccio, F. P., Taggart, F. M., Kandala, N. B., Currie, A., Peile, E., Stranges, S., et al. (2008). Meta-analysis of short sleep duration and obesity in children and adults. *Sleep*, 31(5), 619-626.
- Carroll, J. B. (1993). *Human cognitive abilities*: Cambridge University Press Cambridge.
- Carter, M. A., Dubois, L., & Ramsay, T. (2010). Examining the relationship between obesity and math performance among Canadian school children: a prospective analysis. *Int J Pediatr Obes*, 5(5), 412-419. doi: 10.3109/17477160903496995
- Casazza, K., Fontaine, K. R., Astrup, A., Birch, L. L., Brown, A. W., Bohan Brown, M. M., et al. (2013). Myths, presumptions, and facts about obesity. *New England Journal of Medicine*, 368 (5), 446-454. doi: <http://dx.doi.org/10.1056/NEJMsa1208051>
- Casey, B. J., Tottenham, N., Liston, C., & Durston, S. (2005). Imaging the developing brain: what have we learned about cognitive development? *Trends Cogn Sci*, 9(3), 104-110. doi: 10.1016/j.tics.2005.01.011
- Castelli, D. M., Hillman, C. H., Buck, S. M., & Erwin, H. E. (2007). Physical fitness and academic achievement in third- and fifth-grade students. *J Sport Exerc Psychol*, 29(2), 239-252.
- CDC. (2010). The association between school based physical activity, including physical education, and academic performance. . [http://www.cdc.gov/healthyyouth/health\\_and\\_academics/pdf/pa-pe\\_paper.pdf](http://www.cdc.gov/healthyyouth/health_and_academics/pdf/pa-pe_paper.pdf): Centres for Disease Control and Prevention. U.S. Department of Health and Human Services.
- Ceci, S. J. (1991). How much does schooling influence general intelligence and its cognitive components ? a reassessment of the evidence (English). *Developmental psychology*, 27(5), 703-722.

- Chaddock, L., Erickson, K. I., Prakash, R. S., Kim, J. S., Voss, M. W., Vanpatter, M., et al. (2010). A neuroimaging investigation of the association between aerobic fitness, hippocampal volume, and memory performance in preadolescent children. *Brain Research*, 1358, 172-183.
- Chan, R. C. K., Shum, D., Touloupoulou, T., & Chen, E. Y. H. (2008). Assessment of executive functions: Review of instruments and identification of critical issues. *Archives of Clinical Neuropsychology*, 23(2), 201-216. doi: 10.1016/j.acn.2007.08.010
- Chandola, T., Deary, I. J., Blane, D., & Batty, G. D. (2006). Childhood IQ in relation to obesity and weight gain in adult life: the National Child Development (1958) Study. *Int J Obes (Lond)*, 30(9), 1422-1432. doi: 10.1038/sj.ijo.0803279
- Chen, L.-J., Fox, K. R., Ku, P.-W., & Wang, C.-H. (2012). A Longitudinal Study of Childhood Obesity, Weight Status Change, and Subsequent Academic Performance in Taiwanese Children. *Journal of School Health*, 82(9), 424-431.
- Chen, X., Beydoun, M. A., & Wang, Y. (2008). Is sleep duration associated with childhood obesity? A systematic review and meta-analysis. *Obesity (Silver Spring)*, 16(2), 265-274. doi: 10.1038/oby.2007.63
- Cho, S.-H., Lambert, D. M., Kim, H. J., & Kim, S. G. (2009). Overweight Korean adolescents and academic achievement. *J Fam Econ Iss*, 30:126-136. doi: <http://dx.doi.org/10.1007/s10834-009-9147-x>
- Clark, D., Slate, J. R., & Viglietti, G. C. (2009). Children's weight and academic performance in elementary school: Cause for concern? [References]. *Analyses of Social Issues and Public Policy (ASAP)*, p. doi: <http://dx.doi.org/10.1111/j.1530-2415.2009.01186.x>
- Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ*, 320(7244), 1240-1243.
- Cole, T. J., Freeman, J. V., & Preece, M. A. (1995). Body mass index reference curves for the UK, 1990. *Arch Dis Child*, 73(1), 25-29.
- Cole, T. J., & Lobstein, T. (2012). Extended international (IOTF) body mass index cut-offs for thinness, overweight and obesity. *Pediatr Obes*, 7(4), 284-294. doi: 10.1111/j.2047-6310.2012.00064.x
- Connelly, R. (2011). Drivers of Unhealthy Weight in Childhood: Analysis of the Millennium Cohort Study. Edinburgh: The Scottish Government Social Research.
- Connolly, P. (2006). The effects of social class and ethnicity on gender differences in GCSE attainment: a secondary analysis of the Youth Cohort Study of England and Wales 1997-2001. *British Educational Research Journal*, 32(1), 3-21. doi: 10.1080/01411920500401963
- Corbett, S. S., Drewett, R. F., Durham, M., Tymms, P., & Wright, C. M. (2007). The relationship between birthweight, weight gain in infancy, and educational attainment in childhood. *Paediatric and Perinatal Epidemiology*, 21(1), 57-64. doi: 10.1111/j.1365-3016.2007.00783.x
- Cowansage, K. K., LeDoux, J. E., & Monfils, M.-H. (2010). Brain-derived neurotrophic factor: a dynamic gatekeeper of neural plasticity. *Current molecular pharmacology*, 3(1), 12.

- Creswell, J. W. (2012). *Qualitative inquiry and research design: Choosing among five approaches*: Sage.
- Crosnoe, R. (2007). Gender, obesity, and education. *Sociology of Education*, 80(3), 241-260.
- Currie, J. (2009). Healthy, wealthy, and wise: socioeconomic status, poor health in childhood, and human capital development. *Journal of Economic Literature*, 47(1), 87-122.
- Curtis, P. (2008). The experiences of young people with obesity in secondary school: some implications for the healthy school agenda. *Health Soc Care Community*, 16(4), 410-418. doi: 10.1111/j.1365-2524.2008.00759.x
- Dadaczynski, K. (2012). State of research on the relationship between health and education: An empirical overview and implications for school health promotion. *Zeitschrift Fur Gesundheitspsychologie*, 20(3), 141-153. doi: 10.1026/0943-8149/a000072
- Daniels, S. R. (2009). Complications of obesity in children and adolescents. *Int J Obes (Lond)*, 33 Suppl 1, S60-65.
- Daniels, S. R., & Greer, F. R. (2008). Lipid screening and cardiovascular health in childhood. *Pediatrics*, 122(1), 198-208. doi: 10.1542/peds.2008-1349
- Danielsen, Y. S., Stormark, K. M., Nordhus, I. H., Maehle, M., Sand, L., Ekornas, B., et al. (2012). Factors associated with low self-esteem in children with overweight. *Obes Facts*, 5(5), 722-733. doi: 10.1159/000338333
- Datar, A., & Sturm, R. (2006). Childhood overweight and elementary school outcomes. *Int J Obes (Lond)*, 30(9), 1449-1460. doi: 10.1038/sj.ijo.0803311
- Datar, A., Sturm, R., & Magnabosco, J. L. (2004). Childhood overweight and academic performance: national study of kindergartners and first-graders. *Obes Res*, 12(1), 58-68. doi: 10.1038/oby.2004.9
- Dauncey, M. J. (2009). New insights into nutrition and cognitive neuroscience. *Proc Nutr Soc*, 68(4), 408-415.
- Davidson, T. L., Kanoski, S. E., Walls, E. K., & Jarrard, L. E. (2005). Memory inhibition and energy regulation. *Physiology & Behavior*, 86(5), 731-746. doi: <http://dx.doi.org/10.1016/j.physbeh.2005.09.004>
- Davies, J., Barnes, H., & Dibben, C. (2010). Education administrative data: Exploring the potential for academic research. St Andrews: Administrative Data Liaison Service.
- Davis, C. L., & Cooper, S. (2011). Fitness, fatness, cognition, behavior, and academic achievement among overweight children: Do cross-sectional associations correspond to exercise trial outcomes? *Preventive Medicine*, 52(SUPPL), S65-S69. doi: <http://dx.doi.org/10.1016/j.ypmed.2011.01.020>
- Davis, C. L., Tomporowski, P. D., McDowell, J. E., Austin, B. P., Miller, P. H., Yanasak, N. E., et al. (2011). Exercise improves executive function and achievement and alters brain activation in overweight children: A randomized, controlled trial. *Health Psychol*, 30(1), 91-98.
- Davis, S. P., & Davis, M. (2008). A focus group study of African-American obese children in Mississippi. *Journal of cultural diversity*, 15(4).
- de Groot, F. P., Robertson, N. M., Swinburn, B. A., de Silva-Sanigorski, A. M., de Groot, F. P., Robertson, N. M., et al. (2010). Increasing community capacity

- to prevent childhood obesity: challenges, lessons learned and results from the Romp & Chomp intervention. *BMC Public Health*, 10, 522.
- de Groot, R. H. M., Ouwehand, C., & Jolles, J. (2012). Eating the right amount of fish: Inverted U-shape association between fish consumption and cognitive performance and academic achievement in Dutch adolescents. *Prostaglandins, Leukotrienes and Essential Fatty Acids*, 86(3), 113-117. doi: <http://dx.doi.org/10.1016/j.plefa.2012.01.002>
- Deary, I. J., Strand, S., Smith, P., & Fernandes, C. (2007). Intelligence and educational achievement. *Intelligence*, 35, 13-21.
- Delgado-Rico, E., Rio-Valle, J. S., Albein-Urios, N., Caracuel, A., Gonzalez-Jimenez, E., Piqueras, M. J., et al. (2012a). Effects of a multicomponent behavioral intervention on impulsivity and cognitive deficits in adolescents with excess weight. *Behav Pharmacol*, 23(5-6), 609-615. doi: 10.1097/FBP.0b013e328356c3ac
- Delgado-Rico, E., Rio-Valle, J. S., Gonzalez-Jimenez, E., Campoy, C., & Verdejo-Garcia, A. (2012b). BMI predicts emotion-driven impulsivity and cognitive inflexibility in adolescents with excess weight. *Obesity (Silver Spring)*, 20(8), 1604-1610. doi: 10.1038/oby.2012.47
- Demack, S., & Drew, D. (2000). Minding the gap: ethnic, gender and social class differences in attainment at 16, 1988-95. *Race Ethnicity and Education*, 3(2), 117-143.
- Denzer, C., Reithofer, E., Wabitsch, M., & Widhalm, K. (2004). The outcome of childhood obesity management depends highly upon patient compliance. *Eur J Pediatr*, 163(2), 99-104. doi: 10.1007/s00431-003-1376-7
- Dhingra, A., Brennan, L., & Walkley, J. (2011). Predicting Treatment Initiation in a Family-Based Adolescent Overweight and Obesity Intervention. *Obesity*, 19(6), 1307-1310.
- Diamond, A. (2013). Executive functions. *Annu Rev Psychol*, 64, 135-168. doi: 10.1146/annurev-psych-113011-143750
- Diaper, G. (1990). The Hawthorne Effect: a fresh examination. *Educational Studies*, 16(3), 261-267. doi: 10.1080/0305569900160305
- Dina, C., Meyre, D., Gallina, S., Durand, E., Körner, A., Jacobson, P., et al. (2007). Variation in FTO contributes to childhood obesity and severe adult obesity. *Nature genetics*, 39(6), 724-726.
- Ding, W., Lehrer, S. F., Rosenquist, J. N., & Audrain-McGovern, J. (2009). The impact of poor health on academic performance: New evidence using genetic markers. *J Health Econ*, 28(3), 578-597. doi: S0167-6296(08)00190-2 [pii] 10.1016/j.jhealeco.2008.11.006
- Dishman, R. K., Berthoud, H. R., Booth, F. W., Cotman, C. W., Edgerton, V. R., Fleshner, M. R., et al. (2006). Neurobiology of exercise. *Obesity (Silver Spring)*, 14(3), 345-356.
- Dixey, R., Rudolf, M., & Murtagh, J. (2006). WATCH IT: obesity management for children: a qualitative exploration of the views of parents. *International Journal of Health Promotion and Education*, 44(4), 131-137.
- Do, Y. K., & Finkelstein, E. A. (2011). Adolescent weight status and self-reported school performance in South Korea. *J Obes*, 2011, 798409. doi: 10.1155/2011/798409

- Doutre, G., & Mansfield, D. (2010). *Food for thought. Children's views on the psychological aspects of childhood obesity*. University of Bristol. Retrieved from <http://www.bris.ac.uk/norahfry/teaching-learning/dedpsy/commissions/obesity.pdf>
- Du Toit, D., Pienaar, A. E., & Truter, L. (2011). Relationship between physical fitness and academic performance in South African children. *South African Journal for Research in Sport, Physical Education & Recreation*, 33(3), 23-35.
- Dunlop, A.-W. (2008). Early Education and Childcare. In T. Bryce & W. Humes (Eds.), *Scottish Education Beyond Devolution* (3rd ed., pp. 306-307). Edinburgh: Edinburgh University Press.
- Economos, C. D., Bakun, P. J., Herzog, J. B., Dolan, P. R., Lynskey, V. M., Markow, D., et al. (2012). Children's perceptions of weight, obesity, nutrition, physical activity and related health and socio-behavioural factors. *Public Health Nutr*, 1-9. doi: 10.1017/S136898001200479X
- Edwards, J. U., Mauch, L., & Winkelman, M. R. (2011). Relationship of nutrition and physical activity behaviors and fitness measures to academic performance for sixth graders in a midwest city school district. *J Sch Health*, 81(2), 65-73. doi: 10.1111/j.1746-1561.2010.00562.x
- Egarter, S., Braveman, P., Sadegh-Nobari, T., Grossman-Kahn, R., & Dekker, M. (2009). Education matters for health. *Princeton, NJ: RWJF Commission to Build a Healthier America*.
- Eide, E. R., & Showalter, M. H. (2011). Estimating the relation between health and education: What do we know and what do we need to know? *Economics of Education Review*, 30(5), 778-791. doi: <http://dx.doi.org/10.1016/j.econedurev.2011.03.009>
- Eide, E. R., Showalter, M. H., & Goldhaber, D. D. (2010). The relation between children's health and academic achievement. *Children and Youth Services Review*, 32(2), 231-238. doi: 10.1016/j.childyouth.2009.08.019
- Eime, R. M., Young, J. A., Harvey, J. T., Charity, M. J., & Payne, W. R. (2013). A systematic review of the psychological and social benefits of participation in sport for children and adolescents: informing development of a conceptual model of health through sport. *International Journal of Behavioral Nutrition & Physical Activity*, 10(1).
- Ells, L. J., Hillier, F. C., Shucksmith, J., Crawley, H., Harbige, L., Shield, J., et al. (2008). A systematic review of the effect of dietary exposure that could be achieved through normal dietary intake on learning and performance of school-aged children of relevance to UK schools. *Br J Nutr*, 100(5), 927-936. doi: S0007114508957998 [pii] 10.1017/S0007114508957998
- Ennemoser, M., & Schneider, W. (2007). Relations of Television Viewing and Reading: Findings From a 4-Year Longitudinal Study. *Journal of Educational Psychology*, 99(2), 349-368.
- Epstein, L. H., Paluch, R. A., Gordy, C. C., Saelens, B. E., & Ernst, M. M. (2000). Problem solving in the treatment of childhood obesity. *J Consult Clin Psychol*, 68(4), 717.



- Eveland-Sayers, B. M., Farley, R. S., Fuller, D. K., Morgan, D. W., & Caputo, J. L. (2009). Physical fitness and academic achievement in elementary school children. *J Phys Act Health*, 6(1), 99-104.
- Falkner, N. H., Neumark-Sztainer, D., Story, M., Jeffery, R. W., Beuhring, T., & Resnick, M. D. (2001). Social, educational, and psychological correlates of weight status in adolescents. *Obes Res*, 9(1), 32-42. doi: 10.1038/oby.2001.5
- Fedewa, A. L., & Ahn, S. (2011). The effects of physical activity and physical fitness on children's achievement and cognitive outcomes: a meta-analysis. *Res Q Exerc Sport*, 82(3), 521-535.
- Feinstein, L., Sabates, R., Sorhaindo, A., Rogers, I., Herrick, D., Northstone, K., et al. (2008). Dietary patterns related to attainment in school: the importance of early eating patterns. *J Epidemiol Community Health*, 62(8), 734-739.
- Fewtrell, M. S., Kennedy, K., Singhal, A., Martin, R. M., Ness, A., Hadders-Algra, M., et al. (2008). How much loss to follow-up is acceptable in long-term randomised trials and prospective studies? *Archives of Disease in Childhood*, 93(6), 458-461.
- Fields, S. A., Sabet, M., & Reynolds, B. (2013). Dimensions of impulsive behavior in obese, overweight, and healthy-weight adolescents. *Appetite*, 70, 60-66. doi: 10.1016/j.appet.2013.06.089
- Finch, H., & Lewis, L. (2003). Focus Groups. In L. Ritchie & L. Lewis (Eds.), *Qualitative Research Practice: A Guide for Social Science Students and Researchers* (pp. 170-198): Sage Publications Ltd.
- Fischbacher, C. M., Bhopal, R., Povey, C., Steiner, M., Chalmers, J., Mueller, G., et al. (2007). Record linked retrospective cohort study of 4.6 million people exploring ethnic variations in disease: myocardial infarction in South Asians. *BMC Public Health*, 7, 142. doi: 10.1186/1471-2458-7-142
- Fletcher, J. M. (2010). Adolescent depression and educational attainment: results using sibling fixed effects. *Health Economics*, 19(7), 855-871. doi: 10.1002/hec.1526
- Florence, M. D., Asbridge, M., & Veugelers, P. J. (2008). Diet quality and academic performance. *Journal of School Health*, 78(4), 209-215. doi: 10.1111/j.1746-1561.2008.00288.x
- Florin, T. A., Shults, J., & Stettler, N. (2011). Perception of overweight is associated with poor academic performance in US adolescents. *Journal of School Health*, 81(11), 663-670. doi: <http://dx.doi.org/10.1111/j.1746-1561.2011.00642.x>
- Fonseca, H., Matos, M. G., Guerra, A., & Gomes-Pedro, J. (2011). How much does overweight impact the adolescent developmental process? *Child: care, health and development*, 37(1), 135-142.
- Fowler-Brown, A. G., Ngo, L. H., Phillips, R. S., & Wee, C. C. (2010). Adolescent Obesity and Future College Degree Attainment. *Obesity (19307381)*, 18(6), 1235-1241.
- Fox, K. R., & Edmunds, L. D. (2000). Understanding the World of the "Fat Kid": Can Schools Help Provide a Better Experience? *Reclaiming Children and Youth*, 9(3), 177-181.
- Francis, L. A., & Susman, E. J. (2009). Self-regulation and rapid weight gain in children from age 3 to 12 years. *Arch Pediatr Adolesc Med*, 163(4), 297-302. doi: 10.1001/archpediatrics.2008.579

- Frayling, T. M., Timpson, N. J., Weedon, M. N., Zeggini, E., Freathy, R. M., Lindgren, C. M., et al. (2007). A common variant in the FTO gene is associated with body mass index and predisposes to childhood and adult obesity. *Science*, 316(5826), 889-894.
- Fuxa, A. J., & Fulkerson, J. A. (2011). Adolescent obesity and school performance and perceptions of the school environment among Minnesota high school students. [References]. *School Mental Health*, p. doi: <http://dx.doi.org/10.1007/s12310-011-9050-0>
- Gable, S., Britt-Rankin, J., & Krull, J. L. (2008). *Ecological predictors and developmental outcomes of persistent childhood overweight*: US Department of Agriculture, Economic Research Service.
- Gable, S., Krull, J. L., & Chang, Y. T. (2012). Boys' and Girls' Weight Status and Math Performance From Kindergarten Entry Through Fifth Grade: A Mediated Analysis. *Child Development*, 83(5), 1822-1839. doi: 10.1111/j.1467-8624.2012.01803.x
- Gale, C. R., Batty, G. D., Cooper, C., & Deary, I. J. (2009). Psychomotor coordination and intelligence in childhood and health in adulthood--testing the system integrity hypothesis. *Psychosom Med*, 71(6), 675-681. doi: 10.1097/PSY.0b013e3181a63b2e
- Garratt, E., Barnes, H., & Dibben, C. (2010). Health administrative data: Exploring the potential for academic research. St Andrews: Administrative Data Liaison Service.
- Geddes, R., Haw, S., & Frank, J. (2010). Interventions for Promoting Early Child Development for Health: An environmental scan with special reference to Scotland. Edinburgh: Scottish Collaboration for Public Health Research and Policy.
- Geier, A. B., Foster, G. D., Womble, L. G., McLaughlin, J., Borradaile, K. E., Nachmani, J., et al. (2007). The Relationship Between Relative Weight and School Attendance Among Elementary Schoolchildren. *Obesity*, 15(8), 2157-2161. doi: 10.1038/oby.2007.256
- Glascoe, F. P., & Leew, S. (2010). Parenting Behaviors, Perceptions, and Psychosocial Risk: Impacts on Young Children's Development. *Pediatrics*, 125(2), 313-319. doi: 10.1542/peds.2008-3129
- Glass, G. V. (1976). Primary, secondary, and meta-analysis of research. *Educational Researcher*, 5(10), 3-8.
- Goldfield, G. S., Mallory, R., Parker, T., Cunningham, T., Legg, C., Lumb, A., et al. (2007). Effects of modifying physical activity and sedentary behavior on psychosocial adjustment in overweight/obese children. *Journal of pediatric psychology*, 32(7), 783-793.
- Gomez-Pinilla, F. (2008). Brain foods: the effects of nutrients on brain function. *Nat Rev Neurosci*, 9(7), 568-578.
- Gomez-Pinilla, F. (2011). The combined effects of exercise and foods in preventing neurological and cognitive disorders. *Prev Med*, 52 Suppl 1, S75-80. doi: S0091-7435(11)00051-X [pii] 10.1016/j.ypmed.2011.01.023
- Goodell, L. S., Pierce, M. B., Bravo, C. M., & Ferris, A. M. (2008). Parental Perceptions of Overweight During Early Childhood. *Qualitative Health Research*, 18(11), 1548-1555. doi: 10.1177/1049732308325537

- Gorard, S. (2012). The Increasing Availability of Official Datasets: Methods, Limitations and Opportunities for Studies of Education. *British Journal of Educational Studies*, 60(1), 77-92. doi: 10.1080/00071005.2011.650946
- Gortmaker, S. L., Must, A., Perrin, J. M., Sobol, A. M., & Dietz, W. H. (1993). Social and economic consequences of overweight in adolescence and young adulthood. *New England Journal of Medicine*, 329(14), 1008-1012.
- Gortmaker, S. L., Swinburn, B. A., Levy, D., Carter, R., Mabry, P. L., Finegood, D. T., et al. (2011). Changing the future of obesity: science, policy, and action. *The Lancet*, 378(9793), 838-847.
- Gottfried, M. A. (2011). The Detrimental Effects of Missing School: Evidence from Urban Siblings. *American Journal of Education*, 117(2), 147-182.
- Graham, J. W. (2009). Missing data analysis: making it work in the real world. *Annu Rev Psychol*, 60, 549-576. doi: 10.1146/annurev.psych.58.110405.085530
- Gregg, P., Propper, C., & Washbrook, E. (2008). Understanding the relationship between parental income and multiple child outcomes: a decomposition analysis. *Working Paper No. 08/193* (pp. (accessed 22 November 2013)). [www.bris.ac.uk/Depts/CMPO/workingpapers/wp193.pdf](http://www.bris.ac.uk/Depts/CMPO/workingpapers/wp193.pdf): Centre for Market and Public Organisation, University of Bristol.
- Grieco, L. A., Jowers, E. M., & Bartholomew, J. B. (2009). Physically active academic lessons and time on task: the moderating effect of body mass index. *Med Sci Sports Exerc*, 41(10), 1921-1926. doi: 10.1249/MSS.0b013e3181a61495
- Griffiths, L. J., Parsons, T. J., & Hill, A. J. (2010). Self-esteem and quality of life in obese children and adolescents: a systematic review. *Int J Pediatr Obes*, 5(4), 282-304. doi: 10.3109/17477160903473697
- Grow, H. M. G., Hsu, C., Liu, L. L., Briner, L., Jessen-Fiddick, T., Lozano, P., et al. (2013). Understanding Family Motivations and Barriers to Participation in Community-Based Programs for Overweight Youth: One Program Model Does Not Fit All. *Journal of Public Health Management and Practice*, 19(4), E1-E10. doi: 10.1097/PHH.1090b1013e31825ceaf31829.
- Gunnarsdottir, T., Njardvik, U., Olafsdottir, A., Craighead, L., & Bjarnason, R. (2012a). Teasing and social rejection among obese children enrolling in family-based behavioural treatment: Effects on psychological adjustment and academic competencies. *International Journal of Obesity*, 36(1), 35-44.
- Gunnarsdottir, T., Njardvik, U., Olafsdottir, A. S., Craighead, L., & Bjarnason, R. (2012b). Childhood obesity and co-morbid problems: effects of Epstein's family-based behavioural treatment in an Icelandic sample. *J Eval Clin Pract*, 18(2), 465-472. doi: 10.1111/j.1365-2753.2010.01603.x
- Gurley-Calvez, T., & Higginbotham, A. (2010). Childhood Obesity, Academic Achievement, and School Expenditures. *Public Finance Review*, 38, 619.
- Gustafsson, J.-E., & Undheim, J. O. (1996). Individual differences in cognitive function In D. Berliner & R. Calfee (Eds.), *Handbook of educational psychology* (pp. 186-242). New York: Prentice Hall International.
- Haines, L., Wan, K. C., Lynn, R., Barrett, T. G., & Shield, J. P. (2007). Rising incidence of type 2 diabetes in children in the U.K. *Diabetes Care*, 30(5), 1097-1101. doi: dc06-1813 [pii] 10.2337/dc06-1813



- Halpern, A., Mancini, M. C., Magalhaes, M. E., Fisberg, M., Radominski, R., Bertolami, M. C., et al. (2010). Metabolic syndrome, dyslipidemia, hypertension and type 2 diabetes in youth: from diagnosis to treatment. *Diabetol Metab Syndr*, 2, 55.
- Han, E., Norton, E. C., & Powell, L. M. (2011). Direct and indirect effects of body weight on adult wages. *Econ Hum Biol*, 9(4), 381-392. doi: 10.1016/j.ehb.2011.07.002
- Han, H. (2012). *Does obesity lead to poor school performance? Estimates from propensity score matching* University of Wisconsin-Madison Madison.
- Han, J. C., Lawlor, D. A., & Kimm, S. Y. (2010). Childhood obesity. *Lancet*, 375(9727), 1737-1748.
- Hancox, R. J., Milne, B. J., & Poulton, R. (2005). Association of television viewing during childhood with poor educational achievement. *Arch Pediatr Adolesc Med*, 159(7), 614-618.
- Härkönen, J., Kaymakçalan, H., Mäki, P., & Taanila, A. (2012). Prenatal health, educational attainment, and intergenerational inequality: the northern Finland birth cohort 1966 study. *Demography*, 49(2), 525-552. doi: <http://dx.doi.org/10.1007/s13524-012-0092-1>
- Harvey, J. (2007). Leptin regulation of neuronal excitability and cognitive function. *Curr Opin Pharmacol*, 7(6), 643-647. doi: S1471-4892(07)00177-4 [pii] 10.1016/j.coph.2007.10.006
- Helbig, M., & Jähnen, S. (2013). Bildungsbenachteiligt durch Übergewicht-Online-Anhang. *Zeitschrift für Soziologie*, 42(5), I-VII.
- Hendrie, G. A., Brindal, E., Corsini, N., Gardner, C., Baird, D., & Golley, R. K. (2012). Combined home and school obesity prevention interventions for children: what behavior change strategies and intervention characteristics are associated with effectiveness? (Provisional abstract). *Database of Abstracts of Reviews of Effects*, (3), 159-171. Retrieved from <http://onlinelibrary.wiley.com/o/cochrane/cldare/articles/DARE-12012023995/frame.html>
- Higgins, J. P. T., & Green, S. (Eds.). (2011). *Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]*: The Cochrane Collaboration.
- Hill-Jones, M. L. (2009). An examination of the prevalence of obesity and student performance in a low socioeconomic school district. *Dissertation Abstracts International Section A: Humanities and Social Sciences*, p.
- Hill, L. J., Williams, J. H., Aucott, L., Thomson, J., & Mon-Williams, M. (2011). How does exercise benefit performance on cognitive tests in primary-school pupils? *Dev Med Child Neurol*, 53(7), 630-635. doi: 10.1111/j.1469-8749.2011.03954.x
- Hillman, C. H., Buck, S. M., Themanson, J. R., Pontifex, M. B., & Castelli, D. M. (2009). Aerobic fitness and cognitive development: Event-related brain potential and task performance indices of executive control in preadolescent children. *Dev Psychol*, 45(1), 114-129.
- Hillman, C. H., Kamijo, K., & Scudder, M. (2011). A review of chronic and acute physical activity participation on neuroelectric measures of brain health and cognition during childhood. *Prev Med*. doi: S0091-7435(11)00052-1 [pii] 10.1016/j.ypmed.2011.01.024

- Hillman, C. H., Pontifex, M. B., Motl, R. W., O'Leary, K. C., Johnson, C. R., Scudder, M. R., et al. (2012). From ERPs to academics. *Dev Cogn Neurosci*, 2 Suppl 1, S90-98. doi: 10.1016/j.dcn.2011.07.004
- Hobbs, M. S., & McCall, M. G. (1970). Health statistics and record linkage in Australia. *J Chronic Dis*, 23(5), 375-381.
- Hollar, D., Messiah, S. E., Lopez-Mitnik, G., Hollar, T. L., Almon, M., & Agatston, A. S. (2010). Effect of a two-year obesity prevention intervention on percentile changes in body mass index and academic performance in low-income elementary school children. *Am J Public Health*, 100(4), 646-653. doi: AJP.2009.165746 [pii]  
10.2105/AJP.2009.165746
- Holt, N. L., Moylan, B. A., Spence, J. C., Lenk, J. M., Sehn, Z. L., & Ball, G. D. (2008). Treatment preferences of overweight youth and their parents in Western Canada. *Qual Health Res*, 18(9), 1206-1219. doi: 10.1177/1049732308321740
- Hoyland, A., Dye, L., & Lawton, C. L. (2009). A systematic review of the effect of breakfast on the cognitive performance of children and adolescents. *Nutr Res Rev*, 22(2), 220-243. doi: 10.1017/S0954422409990175
- Hsia, D. S., Fallon, S. C., & Brandt, M. L. (2012). Adolescent bariatric surgery. *Arch Pediatr Adolesc Med*, 166(8), 757-766. doi: 1263348 [pii]  
10.1001/archpediatrics.2012.1011
- Hutson, J. (2008). *The Relationship between Adolescent Obesity Treatment and Academic Performance*. Doctoral thesis, ProQuest.
- Idalski Carcone, A., MacDonell, K. E., Naar-King, S., Ellis, D. A., Cunningham, P. B., & Kaljee, L. (2011). Treatment Engagement in a Weight Loss Intervention for African American Adolescents and Their Families. *Children's Health Care*, 40(3), 232-252. doi: 10.1080/02739615.2011.590398
- IOTF. (2010). Obesity the global epidemic. *Obesity and Research* Retrieved 26 April 2013, from <http://www.iaso.org/iotf/obesity/obesitytheglobalepidemic/>
- ISD. (2013). Child Healthy Weight Interventions (Vol. 2012/13, pp. 1-13): Information Service Devision Scotland.
- Ismail, I. S., Wan Bebakar, W. M., Abdullah, N. H., Zain, F. M., Ismail Noor, M., Singh, R., et al. (2004). Clinical Practice Guidelines on Management of Obesity: Academy of Medicine of Malaysia.
- Janssen, I., & Leblanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *Int J Behav Nutr Phys Act*, 7, 40. doi: 10.1186/1479-5868-7-40
- Johnson, J. G., Cohen, P., Kasen, S., & Brook, J. S. (2007a). Extensive television viewing and the development of attention and learning difficulties during adolescence. *Arch Pediatr Adolesc Med*, 161(5), 480-486. doi: 161/5/480 [pii]  
10.1001/archpedi.161.5.480
- Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher*, 33(7), 14-26.
- Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007b). Toward a definition of mixed methods research. *Journal of mixed methods research*, 1(2), 112-133.
- Johnston, C. A., Moreno, J. P., El-Mubasher, A., Gallagher, M., Tyler, C., & Woehler, D. (2013). Impact of a School-Based Pediatric Obesity Prevention

- Program Facilitated by Health Professionals. *Journal of School Health*, 83(3), 171-181.
- Kaestner, R., & Grossman, M. (2009). Effects of weight on children's educational achievement. *Economics of Education Review* 28, 651-661.
- Kafyulilo, A. C. (2008). *Prevalence and Implications of Overweight and Obesity in Children's Health and Learning Behavior: The Case of Kinondoni and Njombe Districts in Tanzania*. Online Submission. Retrieved from <http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=ED508467&site=ehost-live> Available from EBSCOhost eric database.
- Kamijo, K., Khan, N. A., Pontifex, M. B., Scudder, M. R., Drollette, E. S., Raine, L. B., et al. (2012a). The Relation of Adiposity to Cognitive Control and Scholastic Achievement in Preadolescent Children. *Obesity*, 20(12), 2406-2411.
- Kamijo, K., Pontifex, M. B., Khan, N. A., Raine, L. B., Scudder, M. R., Drollette, E. S., et al. (2012b). The association of childhood obesity to neuroelectric indices of inhibition. *Psychophysiology*, 49(10), 1361-1371. doi: 10.1111/j.1469-8986.2012.01459.x
- Kanoski, S. E., & Davidson, T. L. (2011). Western diet consumption and cognitive impairment: links to hippocampal dysfunction and obesity. *Physiol Behav*, 103(1), 59-68. doi: S0031-9384(10)00450-6 [pii] 10.1016/j.physbeh.2010.12.003
- Kantomaa, M. T., Stamatakis, E., Kankaanpää, A., Kaakinen, M., Rodriguez, A., Taanila, A., et al. (2013). Physical activity and obesity mediate the association between childhood motor function and adolescents' academic achievement. *Proc Natl Acad Sci U S A*, 110(5), 1917-1922. doi: 10.1073/pnas.1214574110
- Kearney, C. A. (2008). School absenteeism and school refusal behavior in youth: A contemporary review. *Clinical Psychology Review*, 28(3), 451-471. doi: <http://dx.doi.org/10.1016/j.cpr.2007.07.012>
- Keels, M. (2009). Ethnic group differences in early head start parents' parenting beliefs and practices and links to children's early cognitive development. *Early Childhood Research Quarterly*, 24(4), 381-397. doi: <http://dx.doi.org/10.1016/j.ecresq.2009.08.002>
- Khang, Y.-H., & Park, M. (2011). Trends in obesity among Korean children using four different criteria. *International Journal of Pediatric Obesity*, 6, 206-214.
- Knaepen, K., Goekint, M., Heyman, E. M., & Meeusen, R. (2010). Neuroplasticity - exercise-induced response of peripheral brain-derived neurotrophic factor: a systematic review of experimental studies in human subjects. *Sports Med*, 40(9), 765-801. doi: 10.2165/11534530-000000000-00000
- Kousta, E., Hadjiathanasiou, C. G., Tolis, G., & Papathanasiou, A. (2009). Pleiotropic genetic syndromes with developmental abnormalities associated with obesity. *J Pediatr Endocrinol Metab*, 22(7), 581-592.
- Kristjansson, A. L., Sigfusdottir, I. D., & Allegrante, J. P. (2010). Health Behavior and Academic Achievement Among Adolescents: The Relative Contribution of Dietary Habits, Physical Activity, Body Mass Index, and Self-Esteem. *Health Education & Behavior*, 37(1), 51-64. doi: 10.1177/1090198107313481

- Kromeyer-Hauschild, K., Wabitsch, M., Kunze, D., Geller, F., Geiß, H. C., Hesse, V., et al. (2001). Perzentile für den Body-mass-Index für das Kindes- und Jugendalter unter Heranziehung verschiedener deutscher Stichproben. *Monatsschrift Kinderheilkunde*, 149(8), 807-818.
- Krueger, R. A., & Casey, A. M. (2009). *Focus groups: A practical guide for applied research* (4th ed.): Sage.
- Krukowski, R. A., Smith West, D., Philyaw Perez, A., Bursac, Z., Phillips, M. M., & Raczynski, J. M. (2009). Overweight children, weight-based teasing and academic performance. *International Journal of Pediatric Obesity*, 4(4), 274-280. doi: <http://dx.doi.org/10.3109/17477160902846203>
- Kuczmarski, R. J., & Flegal, K. M. (2000). Criteria for definition of overweight in transition: background and recommendations for the United States. *Am J Clin Nutr*, 72(5), 1074-1081.
- Kukulu, K., Sarvan, S., Muslu, L., & Yirmibesoglu, S. G. (2010). Dietary habits, economic status, academic performance and body mass index in school children: a comparative study. *Journal of child health care : for professionals working with children in the hospital and community*, 14(4), 355-366.
- Kuratko, C., Barrett, E., Nelson, E., & Salem, N. (2013). The Relationship of Docosahexaenoic Acid (DHA) with Learning and Behavior in Healthy Children: A Review. *Nutrients*, 5(7), 2777-2810.
- Laitinen, J., Power, C., Ek, E., Sovio, U., & Jarvelin, M. R. (2002). Unemployment and obesity among young adults in a northern Finland 1966 birth cohort. *Int J Obes Relat Metab Disord*, 26(10), 1329-1338. doi: 10.1038/sj.ijo.0802134
- Lande, M. B., Kupferman, J. C., & Adams, H. R. (2012). Neurocognitive alterations in hypertensive children and adolescents. *J Clin Hypertens (Greenwich)*, 14(6), 353-359. doi: 10.1111/j.1751-7176.2012.00661.x
- Landhuis, C. E., Poulton, R., Welch, D., & Hancox, R. J. (2007). Does childhood television viewing lead to attention problems in adolescence? Results from a prospective longitudinal study. *Pediatrics*, 120(3), 532-537. doi: 10.1542/peds.2007-0978
- Latner, J. D., Stunkard, A. J., & Wilson, G. T. (2005). Stigmatized students: age, sex, and ethnicity effects in the stigmatization of obesity. *Obes Res*, 13(7), 1226-1231. doi: 10.1038/oby.2005.145
- Lau, D. C., Douketis, J. D., Morrison, K. M., Hramiak, I. M., Sharma, A. M., & Ur, E. (2007). 2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children [summary]. *CMAJ*, 176(8), S1-13. doi: 10.1503/cmaj.061409
- Lawlor, D. A., Clark, H., Davey Smith, G., & Leon, D. A. (2006). Childhood intelligence, educational attainment and adult body mass index: findings from a prospective cohort and within sibling-pairs analysis. *Int J Obes (Lond)*, 30(12), 1758-1765. doi: 10.1038/sj.ijo.0803330
- LeBlanc, M. M., Martin, C. K., Han, H., Newton, R., Sothorn, M., Webber, L. S., et al. (2012). Adiposity and Physical Activity Are Not Related to Academic Achievement in School-Aged Children. *Journal of Developmental and Behavioral Pediatrics*, 33(6), 486-494. doi: 10.1097/DBP.0b013e31825b849e
- Lees, C., & Hopkins, J. (2013). Effect of aerobic exercise on cognition, academic achievement, and psychosocial function in children: a systematic review of

- randomized control trials. *Prev Chronic Dis*, 10, E174. doi: 10.5888/pcd10.130010
- Lefebvre, C. M., & John, R. M. (2013). The effect of breastfeeding on childhood overweight and obesity: A systematic review of the literature. *J Am Assoc Nurse Pract*. doi: 10.1002/2327-6924.12036
- Leidy, H. (2013). The beneficial effects of a protein-rich breakfast on appetite control & cognition in overweight and obese adolescents. Retrieved 21 October 2013, from <http://clinicaltrials.gov/show/NCT01192100>
- Li, J., & O'Connell, A. A. (2012). Obesity, High-Calorie Food Intake, and Academic Achievement Trends Among US School Children. *Journal of Educational Research*, 105(6), 391-403. doi: 10.1080/00220671.2011.646359
- Liang, J., Matheson, B. E., Kaye, W. H., & Boutelle, K. N. (2013). Neurocognitive correlates of obesity and obesity-related behaviors in children and adolescents. *Int J Obes (Lond)*, in press. doi: 10.1038/ijo.2013.142
- Lieberman, A., Robbins, J., & Terras, A. (2009). Why do some adolescents lose weight and others so not: A qualitative study. *J Nati Med Assoc*, 110(5), 439-447.
- Lobstein, T., Baur, L., & Uauy, R. (2004). Obesity in children and young people: a crisis in public health. *Obes Rev*, 5 Suppl 1, 4-104. doi: 10.1111/j.1467-789X.2004.00133.x
- OBR133 [pii]
- Lorentzen, V., Dyeremose, V., & Larsen, B. H. (2012). Severely overweight children and dietary changes--a family perspective. *J Adv Nurs*, 68(4), 878-887. doi: 10.1111/j.1365-2648.2011.05791.x
- Lugo-Gil, J., & Tamis-LeMonda, C. S. (2008). Family Resources and Parenting Quality: Links to Children's Cognitive Development Across the First 3 Years. *Child Development*, 79(4), 1065-1085. doi: 10.1111/j.1467-8624.2008.01176.x
- Maayan, L., Hoogendoorn, C., Sweat, V., & Convit, A. (2011). Disinhibited Eating in Obese Adolescents Is Associated With Orbitofrontal Volume Reductions and Executive Dysfunction. *Obesity*, 19(7), 1382-1387.
- MacCann, C., & Roberts, R. D. (2013). Just as smart but not as successful: obese students obtain lower school grades but equivalent test scores to nonobese students. *Int J Obes (Lond)*, 37(1), 40-46. doi: 10.1038/ijo.2012.47
- MacKay, D. F., Smith, G. C., Dobbie, R., & Pell, J. P. (2010). Gestational age at delivery and special educational need: retrospective cohort study of 407,503 schoolchildren. *PLoS Med*, 7(6), e1000289.
- MacKinnon, D. P., Fairchild, A. J., & Fritz, M. S. (2007). Mediation analysis. *Annu Rev Psychol*, 58, 593-614. doi: 10.1146/annurev.psych.58.110405.085542
- Maffeis, C., Fornari, E., Surano, M. G., Comencini, E., Corradi, M., Tommasi, M., et al. (2012). Breakfast skipping in prepubertal obese children: hormonal, metabolic and cognitive consequences. *Eur J Clin Nutr*, 66(3), 314-321. doi: 10.1038/ejcn.2011.206
- Marmorstein, N. R., Iacono, W. G., & Legrand, L. (2014). Obesity and depression in adolescence and beyond: reciprocal risks. *Int J Obes (Lond)*. doi: 10.1038/ijo.2014.19
- Martin, A., Saunders David, H., Shenkin Susan, D., & Sproule, J. (2014). Lifestyle intervention for improving school achievement in overweight or obese



- children and adolescents. *Cochrane Database of Systematic Reviews*, (3). Retrieved from doi:10.1002/14651858.CD009728.pub2
- Mason, M. (2010). *Sample Size and Saturation in PhD Studies Using Qualitative Interviews*. Paper presented at the Forum: Qualitative Social Research.
- McClure, A. C., Tanski, S. E., Kingsbury, J., Gerrard, M., & Sargent, J. D. (2010). Characteristics associated with low self-esteem among US adolescents. *Acad Pediatr*, 10(4), 238-244 e232. doi: 10.1016/j.acap.2010.03.007
- Merten, M., Wickarama, K., & Williams, A. (2008). Adolescent obesity and young adults psychosocial outcomes: Gender and racial differences. *J Youth Adolescence*, 37, 1111–1122.
- Milosis, D., & Papaioannou, A. (2007). Interdisciplinary teaching, multiple goals and self-concept. In J. Liokkonen, Y. Vanden Auweele, B. Vereijken & Y. Theodorakis (Eds.), *Psychology for Physical Educators: Student in Focus* (2nd ed., pp. 175-198): Champaign, IL Human Kinetics.
- Mo-suwan, L., Lebel, L., Puetpaiboon, A., & Junjana, C. (1999). School performance and weight status of children and young adolescents in a transitional society in Thailand. *International Journal of Obesity*, 23(3), 272-277.
- Molteni, R., Wu, A., Vaynman, S., Ying, Z., Barnard, R. J., & Gomez-Pinilla, F. (2004). Exercise reverses the harmful effects of consumption of a high-fat diet on synaptic and behavioral plasticity associated to the action of brain-derived neurotrophic factor. *Neuroscience*, 123(2), 429-440.
- Mond, J. M., Stich, H., Hay, P. J., Kraemer, A., & Baune, B. T. (2007). Associations between obesity and developmental functioning in pre-school children: a population-based study. *Int J Obes (Lond)*, 31(7), 1068-1073. doi: 10.1038/sj.ijo.0803644
- Murray, N. G., Low, B. J., Hollis, C., Cross, A. W., & Davis, S. M. (2007). Coordinated school health programs and academic achievement: a systematic review of the literature. *J Sch Health*, 77(9), 589-600. doi: 10.1111/j.1746-1561.2007.00238.x
- Murtagh, J., Dixey, R., & Rudolf, M. (2006). A qualitative investigation into the levers and barriers to weight loss in children: opinions of obese children. *Arch Dis Child*, 91(11), 920-923. doi: 10.1136/adc.2005.085712
- Nansel, T. R., Huang, T. T., Rovner, A. J., & Sanders-Butler, Y. (2009). Association of school performance indicators with implementation of the healthy kids, smart kids programme: case study. *Public Health Nutr*, 13(1), 116-122. doi: S1368980009005898 [pii] 10.1017/S1368980009005898
- Nederkoorn, C., Braet, C., Van Eijs, Y., Tanghe, A., & Jansen, A. (2006). Why obese children cannot resist food: the role of impulsivity. *Eat Behav*, 7(4), 315-322. doi: 10.1016/j.eatbeh.2005.11.005
- NHMRC. (2003). *Clinical Practice Guidelines for the Management of Overweight and Obesity in Children and Adolescents*. Australia: National Health and Medical Research Council.
- NHS. (2010). *National Child Measurement Programme: England, 2009/10 school year*. In P. Eastwood (Ed.): The Health and Social Care Information Centre.

- NICE. (2006). Obesity guidance on the prevention, identification, assessment and management of overweight and obesity in adults and children *NICE clinical guideline 43*. London: National Institute for Health and Clinical Excellence.
- NICE. (2013). Managing overweight and obesity among children and young people: lifestyle weight management services. *NICE public health guidance 47*. <http://guidance.nice.org.uk/ph47>: National Institute for Health and Clinical Excellence.
- Northstone, K., Joinson, C., Emmett, P., Ness, A., & Paus, T. (2011). Are dietary patterns in childhood associated with IQ at 8 years of age? A population-based cohort study. *J Epidemiol Community Health*.
- NVivo. (2012). NVivo qualitative data analysis software (Version 10): QSR International Pty Ltd.
- Nyaradi, A., Li, J., Hickling, S., Foster, J., & Oddy, W. H. (2013). The role of nutrition in children's neurocognitive development, from pregnancy through childhood. *Front Hum Neurosci*, 7, 97. doi: 10.3389/fnhum.2013.00097
- O'Reilly, M., & Parker, N. (2013). 'Unsatisfactory Saturation': a critical exploration of the notion of saturated sample sizes in qualitative research. *Qualitative Research*, 13(2), 190-197.
- Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2012). Prevalence of obesity and trends in body mass index among US children and adolescents, 1999-2010. *Jama*, 307(5), 483-490.
- Okunade, A. A., Hussey, A. J., & Karakus, M. C. (2009). Overweight adolescents and on-time high school graduation: Racial and gender disparities. *Atlantic Economic Journal*, 37(3), 225-242.
- Oreopoulos, P., Stabile, M., Walld, R., & Roos, L. L. (2008). Short-, medium-, and long-term consequences of poor infant health an analysis using siblings and twins. *Journal of Human Resources*, 43(1), 88-138.
- Oude Luttikhuis, H., Baur, L., Jansen, H., Shrewsbury, V. A., O'Malley, C., Stolk, R. P., et al. (2009). Interventions for treating obesity in children. *Cochrane Database Syst Rev*(1), CD001872.
- Owen, S. E., Sharp, D. J., Shield, J. P., & Turner, K. M. (2009). Children's' and parents' views and experiences of attending a childhood obesity clinic: a qualitative study. *Primary Health Care Research & Development*, 10(03), 236-244. doi: doi:10.1017/S1463423609990065
- Oxman, A. D., & Guyatt, G. H. (1992). A consumer's guide to subgroup analyses. *Ann Intern Med*, 116(1), 78-84.
- Padilla-Moledo, C., Castro-Pinero, J., Ortega, F. B., Mora, J., Marquez, S., Sjostrom, M., et al. (2012). Positive health, cardiorespiratory fitness and fatness in children and adolescents. *European journal of public health*, 22(1), 52-56. doi: <http://dx.doi.org/10.1093/eurpub/ckr005>
- Pagani, L. S., Fitzpatrick, C., Barnett, T. A., & Dubow, E. (2010). Prospective associations between early childhood television exposure and academic, psychosocial, and physical well-being by middle childhood. *Arch Pediatr Adolesc Med*, 164(5), 425-431. doi: 10.1001/archpediatrics.2010.50
- Palermo, T. M., & Dowd, J. B. (2012). Childhood obesity and human capital accumulation. *Social science & medicine*, 75(11), 1989-1998. doi: 10.1016/j.socscimed.2012.08.004

- Pan, L., Sherry, B., Park, S., & Blanck, H. M. (2013). The association of obesity and school absenteeism attributed to illness or injury among adolescents in the United States, 2009. *Journal of Adolescent Health, 52*(1), 64-69. doi: 10.1016/j.jadohealth.2012.04.003
- Parisi, P., Verrotti, A., Paolino, M. C., Miano, S., Urbano, A., Bernabucci, M., et al. (2010). Cognitive profile, parental education and BMI in children: reflections on common neuroendocrinobiological roots. *Journal of Pediatric Endocrinology, 23*(11), 1133-1141.
- Park, H. R., Park, M., Choi, J., Park, K.-Y., Chung, H. Y., & Lee, J. (2010). A high-fat diet impairs neurogenesis: Involvement of lipid peroxidation and brain-derived neurotrophic factor. *Neuroscience Letters, 482*(3), 235-239. doi: <http://dx.doi.org/10.1016/j.neulet.2010.07.046>
- Paus, T. (2005). Mapping brain maturation and cognitive development during adolescence. *Trends Cogn Sci, 9*(2), 60-68. doi: 10.1016/j.tics.2004.12.008
- Paz-Filho, G., Wong, M. L., & Licinio, J. (2010). The procognitive effects of leptin in the brain and their clinical implications. *International Journal of Clinical Practice, 64*(13), 1808-1812. doi: 10.1111/j.1742-1241.2010.02536.x
- Pearson, E. S., Irwin, J. D., & Burke, S. M. (2012). The Children's Health and Activity Modification Program (C.H.A.M.P.): participants' perspectives of a four-week lifestyle intervention for children with obesity. *J Child Health Care, 16*(4), 382-394. doi: 10.1177/1367493512446239
- Pell, J., Wood, R., King, A., MacKay, D., Reynolds, L., Morris, C., et al. (2012). Impact of health interventions on educational outcomes: An exemplar study of the management of breech infants Retrieved 14 December 2012
- Perez-Chada, D., Drake, C. L., Perez-Lloret, S., Videla, A. J., & Cardinali, D. P. (2009). Brief review: diurnal rhythms, obesity and educational achievement in South american cultures. *Int J Neurosci, 119*(8), 1091-1104. doi: 10.1080/00207450802333961 [pii]
- Pesa, J. A., Syre, T. R., & Jones, E. (2000). Psychosocial differences associated with body weight among female adolescents: the importance of body image. *Journal of Adolescent Health, 26*(5), 330-337. doi: [http://dx.doi.org/10.1016/S1054-139X\(99\)00118-4](http://dx.doi.org/10.1016/S1054-139X(99)00118-4)
- Pittson, H., & Wallace, L. (2011). Using intervention mapping to develop a family-based childhood weight management programme. *J Health Serv Res Policy, 16 Suppl 1*, 2-7. doi: 10.1258/jhsrp.2010.010076
- Praphul, J., Howat, H., & Bryan, C. (2011). Relationship Between Fitness Levels and Academic Performance. *Journal of Physical Education & Sport, 11*(44), 376-382.
- Pratt, K. J., Lazorick, S., Lamson, A. L., Ivanescu, A., & Collier, D. N. (2013). Quality of life and BMI changes in youth participating in an integrated pediatric obesity treatment program. *Health Qual Life Outcomes, 11*(1), 116. doi: 10.1186/1477-7525-11-116
- Puder, J. J., & Munsch, S. (2010). Psychological correlates of childhood obesity. *Int J Obes (Lond), 34 Suppl 2*, S37-43.
- Puhl, R. M., & King, K. M. (2013). Weight discrimination and bullying. *Best Pract Res Clin Endocrinol Metab, 27*(2), 117-127. doi: 10.1016/j.beem.2012.12.002
- Puhl, R. M., & Latner, J. D. (2007). Stigma, obesity, and the health of the nation's children. *Psychol Bull, 133*(4), 557-580. doi: 10.1037/0033-2909.133.4.557



- Ramaswamy, R., Mirochna, M., & Perlmutter, L. C. (2010). The negative association of BMI with classroom effort in elementary school children. *Journal of Child Health Care, 14*(2), 161-169. doi: 10.1177/1367493509359222
- Rampersaud, G. C. (2009). Benefits of Breakfast for Children and Adolescents: Update and Recommendations for Practitioners. *American Journal of Lifestyle Medicine, 3*(2), 86-103. doi: 10.1177/1559827608327219
- Rappaport, E. B., Daskalakis, C., & Andrel, J. (2011). Obesity and Other Predictors of Absenteeism in Philadelphia School Children. *Journal of School Health, 81*(6), 341-344. doi: 10.1111/j.1746-1561.2011.00599.x
- Rauner, A., Mess, F., & Woll, A. (2013). The relationship between physical activity, physical fitness and overweight in adolescents: a systematic review of studies published in or after 2000. *BMC Pediatr, 13*, 19. doi: 1471-2431-13-19 [pii] 10.1186/1471-2431-13-19
- Reed, J. A., Maslow, A. L., Long, S., & Hughey, M. (2012). Examining the Impact of 45 Minutes of Daily Physical Education on Cognitive Ability, Fitness Performance, and Body Composition of African American Youth. *J Phys Act Health. doi: 2011-0037 [pii]*
- Reid, L. (2008). The Primary Curriculum beyond 5-14: The Evolution of Curriculum for Excellence. In T. Bryce & W. Humes (Eds.), *Scottish Education Beyond Devolution* (3rd ed., pp. 333-343). Edinburgh: Edinburgh University Press.
- Reilly, J. J., Armstrong, J., Dorosty, A. R., Emmett, P. M., Ness, A., Rogers, I., et al. (2005). Early life risk factors for obesity in childhood: cohort study. *BMJ, 330*(7504), 1357. doi: 10.1136/bmj.38470.670903.E0
- Reilly, J. J., Kelly, J., & Wilson, D. C. (2010). Accuracy of simple clinical and epidemiological definitions of childhood obesity: systematic review and evidence appraisal. *Obes Rev, 11*(9), 645-655. doi: OBR709 [pii] 10.1111/j.1467-789X.2009.00709.x
- Reilly, J. J., Methven, E., McDowell, Z. C., Hacking, B., Alexander, D., Stewart, L., et al. (2003). Health consequences of obesity. *Arch Dis Child, 88*(9), 748-752.
- Reinehr, T. (2013). Lifestyle intervention in childhood obesity: changes and challenges. *Nat Rev Endocrinol, 9*(10), 607-614. doi: 10.1038/nrendo.2013.149
- RevMan. (2012). Review Manager (Version 5.2). Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration.
- Rey-Lopez, J. P., Vicente-Rodriguez, G., Biosca, M., & Moreno, L. A. (2008). Sedentary behaviour and obesity development in children and adolescents. *Nutr Metab Cardiovasc Dis, 18*(3), 242-251. doi: S0939-4753(07)00169-X [pii] 10.1016/j.numecd.2007.07.008
- Ridderinkhof, K. R., Ullsperger, M., Crone, E. A., & Nieuwenhuis, S. (2004). The role of the medial frontal cortex in cognitive control. *Science, 306*(5695), 443-447. doi: 10.1126/science.1100301
- Riggs, N. R., Spruijt-Metz, D., Chou, C. P., & Pentz, M. A. (2012). Relationships between executive cognitive function and lifetime substance use and obesity-related behaviors in fourth grade youth. *Child Neuropsychol, 18*(1), 1-11. doi: 10.1080/09297049.2011.555759

- Ritchie, J., Lewis, J., & Elam, G. (2003). Designing and selecting samples. In J. Ritchie & J. Lwewis (Eds.), *Qualitative Research Practice: A Guide for Social Science Students and Researchers* (pp. 83-84): Sage Publications Ltd.
- Roberts, C. K., Freed, B., & McCarthy, W. J. (2010). Low aerobic fitness and obesity are associated with lower standardized test scores in children. *J Pediatr*, 156(5), 711-718, 718 e711. doi: S0022-3476(09)01148-2 [pii]  
10.1016/j.jpeds.2009.11.039
- Robinson, T. N., Matheson, D. M., Kraemer, H. C., Wilson, D. M., Obarzanek, E., Thompson, N. S., et al. (2010). A Randomized Controlled Trial of Culturally Tailored Dance and Reducing Screen Time to Prevent Weight Gain in Low-Income African American Girls: Stanford GEMS. *Archives of Pediatrics & Adolescent Medicine*, 164(11), 995-1004.
- Rolland-Cachera, M. F. (2011). Childhood obesity: current definitions and recommendations for their use. *Int J Pediatr Obes*, 6(5-6), 325-331. doi: 10.3109/17477166.2011.607458
- Rolls, E. T. (2004). The functions of the orbitofrontal cortex. *Brain Cogn*, 55(1), 11-29. doi: 10.1016/S0278-2626(03)00277-X
- Rothman, S. M., Griffioen, K. J., Wan, R., & Mattson, M. P. (2012). Brain-derived neurotrophic factor as a regulator of systemic and brain energy metabolism and cardiovascular health. *Annals of the New York Academy of Sciences*, 1264(1), 49-63. doi: 10.1111/j.1749-6632.2012.06525.x
- Royston, P. (2009). Multiple imputation of missing values: Further update of **ice**, with an emphasis on categorical variables. *The Stata Journal*, 9(3), 466-477.
- Rubin, D. (1987). *Multiple Imputation for Nonresponse in Surveys*: John Wiley & Sohn.
- Ruiz, J. R., Ortega, F. B., Castillo, R., Martin-Matillas, M., Kwak, L., Vicente-Rodriguez, G., et al. (2010). Physical activity, fitness, weight status, and cognitive performance in adolescents. *J Pediatr*, 157(6), 917-922 e911-915. doi: S0022-3476(10)00517-2 [pii]  
10.1016/j.jpeds.2010.06.026
- Sabia, J. J. (2007). The Effect of Body Weight on Adolescent Academic Performance. *Southern Economic Journal*, 73(4), 871-900. doi: 10.2307/20111933
- Sabia, J. J., & Rees, D. I. (2012). Body weight and wages: evidence from Add Health. *Econ Hum Biol*, 10(1), 14-19. doi: 10.1016/j.ehb.2011.09.004
- Sallinen, B. J., Schaffer, S., & Woolford, S. J. (2013). In their own words: learning from families attending a multidisciplinary pediatric weight management program at the YMCA. *Child Obes*, 9(3), 200-207. doi: 10.1089/chi.2012.0106
- Sanchez-Lopez, M., Salcedo-Aguilar, F., Solera-Martinez, M., Moya-Martinez, P., Notario-Pacheco, B., & Martinez-Vizcaino, V. (2009). Physical activity and quality of life in schoolchildren aged 11-13 years of Cuenca, Spain. *Scandinavian Journal of Medicine & Science in Sports*, 19(6), 879-884. doi: 10.1111/j.1600-0838.2008.00839.x
- Sandjaja, Poh, B. K., Rojroonwasinkul, N., Le Nyugen, B. K., Budiman, B., Ng, L. O., et al. (2013). Relationship between anthropometric indicators and cognitive performance in Southeast Asian school-aged children. *Br J Nutr*, 110 Suppl 3, S57-64. doi: 10.1017/s0007114513002079

- Sargent, G. M., Pilotto, L. S., & Baur, L. A. (2011). Components of primary care interventions to treat childhood overweight and obesity: a systematic review of effect (Structured abstract). *Obesity Reviews*, (501), e219-e235. Retrieved from <http://onlinelibrary.wiley.com/o/cochrane/cldare/articles/DARE-12011002915/frame.html>
- Sargent, J. D., & Blanchflower, D. G. (1994). Obesity and stature in adolescence and earnings in young adulthood. Analysis of a British birth cohort. *Arch Pediatr Adolesc Med*, 148(7), 681-687.
- Serdula, M. K., Ivery, D., Coates, R. J., Freedman, D. S., Williamson, D. F., & Byers, T. (1993). Do Obese Children Become Obese Adults? A Review of the Literature. *Preventive Medicine*, 22(2), 167-177. doi: <http://dx.doi.org/10.1006/pmed.1993.1014>
- Shamliyan, T. A., Kane, R. L., Ansari, M. T., Raman, G., Berkman, N. D., Grant, M., et al. (2011). Development quality criteria to evaluate nontherapeutic studies of incidence, prevalence, or risk factors of chronic diseases: pilot study of new checklists. *J Clin Epidemiol*, 64(6), 637-657. doi: 10.1016/j.jclinepi.2010.08.006
- Shenkin, S. D., Starr, J. M., & Deary, I. J. (2004). Birth weight and cognitive ability in childhood: a systematic review. *Psychol Bull*, 130(6), 989-1013. doi: 10.1037/0033-2909.130.6.989
- Shilts, M. K., Lamp, C., Horowitz, M., & Townsend, M. S. (2009). Pilot study: EatFit impacts sixth graders' academic performance on achievement of mathematics and english education standards. *J Nutr Educ Behav*, 41(2), 127-131. doi: S1499-4046(08)00692-1 [pii] 10.1016/j.jneb.2008.05.007
- SHIP. (2010). A document of the SHIP Information Governance Working Group. In E. Postan & S. Sutherland (Eds.), *SHIP Guiding Principles and Best Practices* (pp. 1-18). [http://www.scotship.ac.uk/sites/default/files/Reports/Guiding\\_Principles\\_and\\_Best\\_Practices\\_221010.pdf](http://www.scotship.ac.uk/sites/default/files/Reports/Guiding_Principles_and_Best_Practices_221010.pdf). Scottish Health Informatics Programme.
- Shore, S. M., Sachs, M. L., Lidicker, J. R., Brett, S. N., Wright, A. R., & Libonati, J. R. (2008). Decreased scholastic achievement in overweight middle school students. *Obesity (Silver Spring)*, 16(7), 1535-1538. doi: oby2008254 [pii] 10.1038/oby.2008.254
- Sibley, B. A., & Etnier, J. L. (2003). The Relationship Between Physical Activity and Cognition in Children: A Meta-Analysis. *Pediatric Exercise Science*, 15, 243-256.
- Sibley, B. A., Ward, R. M., Yazvac, T. S., Zullig, K., & Potteiger, J. A. (2008). Making the grade with diet and physical activity. *Journal of Scholarship and Practice*, 5(2), 38-45.
- SIGN. (2010). Scottish Intercollegiate Guidelines Network (SIGN) Guidelines *Management of Obesity* (Vol. 115, pp. 34-45). Edinburgh.
- Simon, C., Wagner, A., DiVita, C., Rauscher, E., Klein-Platat, C., Arveiler, D., et al. (2004). Intervention centred on adolescents' physical activity and sedentary behaviour (ICAPS): concept and 6-month results. *International Journal of Obesity*, 28, S96-S103.
- Singh, A., Uijtdewilligen, L., Twisk, J. W., van Mechelen, W., & Chinapaw, M. J. (2012). Physical activity and performance at school: a systematic review of

- the literature including a methodological quality assessment. *Arch Pediatr Adolesc Med*, 166(1), 49-55. doi: 10.1001/archpediatrics.2011.716
- Singh, A. S., Mulder, C., Twisk, J. W., Van Mechelen, W., & Chinapaw, M. J. (2008). Tracking of childhood overweight into adulthood: a systematic review of the literature. *Obesity reviews*, 9(5), 474-488.
- Skledar, M., Nikolac, M., Dodig-Curkovic, K., Curkovic, M., Borovecki, F., & Pivac, N. (2012). Association between brain-derived neurotrophic factor Val66Met and obesity in children and adolescents. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, 36(1), 136-140.
- Speiser, P. W., Rudolf, M. C., Anhalt, H., Camacho-Hubner, C., Chiarelli, F., Eliakim, A., et al. (2005). Childhood obesity. *J Clin Endocrinol Metab*, 90(3), 1871-1887. doi: 10.1210/jc.2004-1389
- Spruyt, K., & Gozal, D. (2012). A mediation model linking body weight, cognition, and sleep-disordered breathing. *American Journal of Respiratory and Critical Care Medicine*, 185(2), 199-205. doi: <http://dx.doi.org/10.1164/rccm.201104-0721OC>
- Staiano, A. E., Abraham, A. A., & Calvert, S. L. (2012). Competitive versus cooperative exergame play for African American adolescents' executive function skills: short-term effects in a long-term training intervention. *Developmental psychology*, (2), 337-342. Retrieved from <http://onlinelibrary.wiley.com/o/cochrane/clcentral/articles/260/CN-00832260/frame.html> doi:10.1037/a0026938
- StataCorp. (2009). Stata Statistical Software: Release 11. College Station, TX: StataCorp LP.
- Stewart, L., Chapple, J., Hughes, A. R., Poustie, V., & Reilly, J. J. (2008). Parents' journey through treatment for their child's obesity: a qualitative study. *Archives of Disease in Childhood*, 93(1), 35-39. doi: 10.1136/adc.2007.125146
- Stewart, L., Houghton, J., Hughes, A. R., Pearson, D., & Reilly, J. J. (2005). Dietetic management of pediatric overweight: development and description of a practical and evidence-based behavioral approach. *J Am Diet Assoc*, 105(11), 1810-1815. doi: 10.1016/j.jada.2005.08.006
- Stranahan, A. M., & Mattson, M. P. (2008). Impact of energy intake and expenditure on neuronal plasticity. *Neuromolecular Med*, 10(4), 209-218.
- Suhrcke, M., & de Paz Nieves, C. (2011). The impact of health and health behaviours on educational outcomes in highincome countries: a review of the evidence. . In M. Suhrcke & C. de Paz Nieves (Eds.): Copenhagen, WHO Regional Office for Europe.
- Suldo, S., Thalji, A., & Ferron, J. (2011). Longitudinal academic outcomes predicted by early adolescents' subjective well-being, psychopathology, and mental health status yielded from a dual factor model. *The Journal of Positive Psychology*, 6(1), 17-30. doi: 10.1080/17439760.2010.536774
- Swinburn, B. A., Sacks, G., Hall, K. D., McPherson, K., Finegood, D. T., Moodie, M. L., et al. (2011). The global obesity pandemic: shaped by global drivers and local environments. *Lancet*, 378(9793), 804-814. doi: 10.1016/S0140-6736(11)60813-1

- Symons, C. W., Cinelli, B., James, T. C., & Groff, P. (1997). Bridging student health risks and academic achievement through comprehensive school health programs. *J Sch Health*, 67(6), 220-227.
- Tan, E., Healey, D., Schaughency, E., Dawes, P., & Galland, B. (2013). Neurobehavioural correlates in older children and adolescents with obesity and obstructive sleep apnoea. *J Paediatr Child Health*. doi: 10.1111/jpc.12390
- Tang-Peronard, J. L., & Heitmann, B. L. (2008). Stigmatization of obese children and adolescents, the importance of gender. *Obes Rev*, 9(6), 522-534. doi: 10.1111/j.1467-789X.2008.00509.x
- Taras, H., & Potts-Datema, W. (2005). Obesity and student performance at school. *J Sch Health*, 75(8), 291-295.
- Taveras, E. M., Hohman, K. H., Price, S. N., Rifas-Shiman, S. L., Mitchell, K., Gortmaker, S. L., et al. (2011). Correlates of Participation in a Pediatric Primary Care-Based Obesity Prevention Intervention. *Obesity*, 19(2), 449-452.
- Taylor, L., & Lynch, E. (2010). Linking social care, housing & health data: Data Linkage literature review 2010 Paper 1 <http://www.scotland.gov.uk/Resource/Doc/924/0119579.pdf>: Health Analytical Services Division , Scottish Government.
- Taylor, R. W., Williams, S. M., Dawson, A. M., Taylor, B. J., Meredith-Jones, K., & Brown, D. (2013). What factors influence uptake into family-based obesity treatment after weight screening? *The Journal of pediatrics*, 163(6), 1657-1662. e1651.
- Telford, R. D., Cunningham, R. B., Telford, R. M., & Abharatna, W. P. (2012). Schools With Fitter Children Achieve Better Literacy and Numeracy Results: Evidence of a School Cultural Effect. *Pediatric Exercise Science*, 24(1), 45-57.
- The Scottish Government. (2007, 04 June 2013). Schools (Health Promotion and Nutrition) (Scotland) Act 2007. *Health Promotion and Nutrition in Schools* Retrieved 19 January 2014, from <http://www.scotland.gov.uk/Topics/Education/Schools/HLivi/foodnutrition>
- The Scottish Government. (2008). Healthy Eating, Active Living: An action plan to improve diet, increase physical activity and tackle obesity (2008-2011). Edinburgh: The Scottish Government.
- The Scottish Government. (2010a). Health and Wellbeing. *Learning, Teaching and Assessment. Curriculum areas* Retrieved 19 January 2014, from <http://www.educationscotland.gov.uk/learningteachingandassessment/curriculumareas/healthandwellbeing/>
- The Scottish Government. (2010b). Preventing overweight and obesity in Scotland: A route map towards healthy weight. Edinburgh: The Scottish Government.
- The Scottish Government. (2012a, 18 December 2012). Background and Methodology. *The Scottish Index of Multiple Deprivation* Retrieved 08 December 2013, from <http://www.scotland.gov.uk/Topics/Statistics/SIMD/BackgroundMethodology>

- The Scottish Government. (2012b). Consultation Paper on the Aims and Guiding Principles A *Scotland-wide Data Linkage Framework for Statistics and Research*. Edinburgh: The Scottish Government.
- The Scottish Government. (2013a, 29 August 2013). H3: Child Healthy Weight. *Scotland Performs: NHS Scotland* Retrieved 19 September 2013, from <http://www.scotland.gov.uk/About/Performance/scotPerforms/partnerstories/NHSScotlandperformance/childhealthyweight>
- The Scottish Government. (2013b, 8 March 2013). Historical school, pupil and teacher numbers, 1966 to 2012. *Dataseries - Historical figures* Retrieved 08 December 2013, from <http://www.scotland.gov.uk/Topics/Statistics/Browse/School-Education/HistoricDatasets/PupilTeacherHistoric>
- The Scottish Government. (2013c, 21 January 2013). Pupil Census Results. *School Education - Publications* Retrieved 09 December 2013, from <http://www.scotland.gov.uk/Topics/Statistics/Browse/School-Education/PubPupilCensus>
- The Scottish Government. (2013d). Scottish Survey of Literacy and Numeracy 2012 (Literacy) *Statistics Publication Notice* (pp. page 15).
- Theodore, R. F., Thompson, J. M. D., Waldie, K. E., Wall, C., Becroft, D. M. O., Robinson, E., et al. (2009). Dietary patterns and intelligence in early and middle childhood. *Intelligence*, 37(5), 506-513. doi: <http://dx.doi.org/10.1016/j.intell.2009.07.001>
- Tomprowski, P. D., Davis, C. L., Lambourne, K., Gregoski, M., & Tkacz, J. (2008). Task switching in overweight children: effects of acute exercise and age. *J Sport Exerc Psychol*, 30(5), 497-511.
- Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. *British Journal of Management*, 14(3), 207-222. doi: 10.1111/1467-8551.00375
- Tremblay, M. S., LeBlanc, A. G., Kho, M. E., Saunders, T. J., Larouche, R., Colley, R. C., et al. (2011). Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *Int J Behav Nutr Phys Act*, 8, 98. doi: 10.1186/1479-5868-8-98
- Tyler, D. O., & Horner, S. D. (2008). Collaborating With Low-Income Families and Their Overweight Children to Improve Weight-Related Behaviors: An Intervention Process Evaluation. *Journal for Specialists in Pediatric Nursing*, 13(4), 263-274. doi: 10.1111/j.1744-6155.2008.00167.x
- Van Dusen, D. P., Kelder, S. H., Kohl, H. W., Ranjit, N., & Perry, C. L. (2011). Associations of Physical Fitness and Academic Performance Among Schoolchildren. *Journal of School Health*, 81(12), 733-740. doi: 10.1111/j.1746-1561.2011.00652.x
- van Lier, P. A., Vitaro, F., Barker, E. D., Brendgen, M., Tremblay, R. E., & Boivin, M. (2012). Peer victimization, poor academic achievement, and the link between childhood externalizing and internalizing problems. *Child Development*, 83(5), 1775-1788.
- Vanhelst, J., Beghin, L., Fardy, P. S., Bui-Xuan, G., & Mikulovic, J. (2012). A conative educational model for an intervention program in obese youth. *BMC Public Health*, 12, 416. doi: 1471-2458-12-416 [pii]



10.1186/1471-2458-12-416

- Vansteenkiste, M., Simmons, J., Braet, C., Bachman, C., & Deci, E. L. (2007). *Promoting maintained weight loss through healthy lifestyle changes among severely obese children: An experimental test of self-determination theory*. Unpublished manuscript. University of Ghent, Belgium.
- Varni, J. W., Burwinkle, T. M., Seid, M., & Skarr, D. (2003). The PedsQL 4.0 as a pediatric population health measure: feasibility, reliability, and validity. *Ambul Pediatr*, 3(6), 329-341.
- Vaynman, S., Ying, Z., Wu, A., & Gomez-Pinilla, F. (2006). Coupling energy metabolism with a mechanism to support brain-derived neurotrophic factor-mediated synaptic plasticity. *Neuroscience*, 139(4), 1221-1234.
- Veena, S. R., Hegde, B. G., Ramachandraiah, S., Krishnaveni, G. V., Fall, C. H., & Srinivasan, K. (2013). Relationship between adiposity and cognitive performance in 9-10-year-old children in South India. *Arch Dis Child*. doi: 10.1136/archdischild-2013-304478
- Veldwijk, J., Fries, M. C. E., Bemelmans, W. J. E., Haveman-Nies, A., Smit, H. A., Koppelman, G. H., et al. (2012). Overweight and school performance among primary school children: The PIAMA birth cohort study. *Obesity*, 20(3), 590-596. doi: <http://dx.doi.org/10.1038/oby.2011.327>
- Veldwijk, J., Scholtens, S., Hornstra, G., & Bemelmans, W. J. (2011). Body mass index and cognitive ability of young children. *Obes Facts*, 4(4), 264-269. doi: 10.1159/000331015
- Verbeken, S., Braet, C., Goossens, L., & van der Oord, S. (2013a). Executive function training with game elements for obese children: a novel treatment to enhance self-regulatory abilities for weight-control. *Behav Res Ther*, 51(6), 290-299. doi: 10.1016/j.brat.2013.02.006
- Verbeken, S., Braet, C., Goossens, L., & van der Oord, S. (2013b). Executive function training with game elements for obese children: A novel treatment to enhance self-regulatory abilities for weight-control. *Behaviour Research and Therapy*, 51 (6), 290-299. doi: <http://dx.doi.org/10.1016/j.brat.2013.02.006>
- Viner, R. M., & Cole, T. J. (2005). Adult socioeconomic, educational, social, and psychological outcomes of childhood obesity: a national birth cohort study. *BMJ*, 330(7504), 1354. doi: 10.1136/bmj.38453.422049.E0
- Von Hinke Kessler Scholder, S., Davey Smith, G., Lawlor, D. A., Propper, C., & Windmeijer, F. (2012). The effect of fat mass on educational attainment: Examining the sensitivity to different identification strategies. *Economics and Human Biology*, 10(4), 405-418. doi: <http://dx.doi.org/10.1016/j.ehb.2012.04.015>
- Vos, R. C., Wit, J. M., Pijl, H., Kruijff, C. C., & Houdijk, E. C. A. M. (2011). The effect of family-based multidisciplinary cognitive behavioral treatment in children with obesity: study protocol for a randomized controlled trial. *Trials [Electronic Resource]*, 12, 110.
- Waber, D. P., De Moor, C., Forbes, P. W., Almli, C. R., Botteron, K. N., Leonard, G., et al. (2007). The NIH MRI study of normal brain development: performance of a population based sample of healthy children aged 6 to 18 years on a neuropsychological battery. *J Int Neuropsychol Soc*, 13(5), 729-746. doi: 10.1017/S1355617707070841

- Waters, E., de Silva-Sanigorski, A., Hall, B. J., Brown, T., Campbell, K. J., Gao, Y., et al. (2011). Interventions for preventing obesity in children. *Cochrane Database Syst Rev*(12), CD001871. doi: 10.1002/14651858.CD001871.pub3
- Welk, G. J., Jackson, A. W., Morrow, J. R., Haskell, W. H., Meredith, M. D., & Cooper, K. H. (2010). The Association of Health-Related Fitness With Indicators of Academic Performance in Texas Schools. *Research Quarterly for Exercise and Sport*, 81(3), S16-S23.
- Wendt, M. (2009). *Economic, environmental and endowment effects on childhood obesity and school performance.*, University of Minnesota, unpublished doctoral thesis.
- White, I. R., Royston, P., & Wood, A. M. (2011). Multiple imputation using chained equations: Issues and guidance for practice. *Statistics in Medicine*, 30(4), 377-399. doi: 10.1002/sim.4067
- Whitham, M. D. (2012). Combining Health, Social Services and Functional data for older people in Tayside – a multisource, interdisciplinary record linkage project. Retrieved 14 December 2013
- WHO. (1998). Health Promotion Glossary. In **D. Nutbeam** (Ed.), (pp. 16). Geneva: World Health Organisation.
- WHO. (2003). Report of a Joint WHO/FAO Expert Consultation. Diet, nutrition and the prevention of chronic diseases. *WHO technical report series*, 916.
- WHO. (2008). Obesity and Overweight Retrieved 22 February, 2011
- WHO. (2010). Global Recommendations on Physical Activity for Health *Global Strategy on Diet, Physical Activity and Health* (pp. 17-22). Geneva: World Health Organisation.
- WHO. (2012). Prioritizing areas for action in the field of population-based prevention of childhood obesity: a set of tools for Member States to determine and identify priority areas for action. (pp. 11-22). Geneva: World Health Organisation.
- WHO. (2014). Childhood overweight and obesity. *Global Strategy on Diet, Physical Activity and Health* Retrieved 22 January 2014, from <http://www.who.int/dietphysicalactivity/childhood/en/>
- Wilfley, D. E., Tibbs, T. L., Van Buren, D. J., Reach, K. P., Walker, M. S., & Epstein, L. H. (2007). Lifestyle interventions in the treatment of childhood overweight: a meta-analytic review of randomized controlled trials. *Health Psychol*, 26(5), 521-532. doi: 10.1037/0278-6133.26.5.521
- Wilson, P., Wood, R., Reynolds, L., Thomson, L., Forde, M., & McClung, M. (2013). Enhancing information systems to support children's health and development: exploring options in Glasgow Retrieved 14 December 2013
- Winding, T. N., Nohr, E. A., Labriola, M., Biering, K., & Andersen, J. H. (2013). Personal predictors of educational attainment after compulsory school: influence of measures of vulnerability, health, and school performance. *Scandinavian journal of public health*, 41(1), 92-101. doi: <http://dx.doi.org/10.1177/1403494812467713>
- Winter, S. M., & Sass, D. A. (2011). Healthy & ready to learn: examining the efficacy of an early approach to obesity prevention and school readiness. *Journal of Research in Childhood Education*, 25(3), 304-325.
- Wirt, T., Schreiber, A., Dreyhaupt, J., Kesztyues, D., Hundsdoerfer, V., & Steinacker, J. (2013). Health promotion in primary schools and cognitive



- performance - evaluation of transfer effects of a school based programme.  
*unpublished.*
- Wong, P., Boh, B. T. G., Wang, C. K. J., & Chia, Y. H. M. (2007). Relationship between obesity and verbal memory performance among top academic achievers in Singapore. *Asian Journal of Exercise & Sports Science*, 4(1), 47-55.
- Woo, J., Shin, K. O., Park, S. Y., Jang, K. S., & Kang, S. (2013). Effects of exercise and diet change on cognition function and synaptic plasticity in high fat diet induced obese rats. *Lipids Health Dis*, 12(1), 144. doi: 10.1186/1476-511X-12-144
- Yang, W., Kelly, T., & He, J. (2007). Genetic Epidemiology of Obesity. *Epidemiologic Reviews*, 29(1), 49-61. doi: 10.1093/epirev/mxm004
- Yates, K. F., Sweat, V., Yau, P. L., Turchiano, M. M., & Convit, A. (2012). Impact of metabolic syndrome on cognition and brain: a selected review of the literature. *Arterioscler Thromb Vasc Biol*, 32(9), 2060-2067. doi: 10.1161/ATVBAHA.112.252759
- Yau, P. L., Castro, M. G., Tagani, A., Tsui, W. H., & Convit, A. (2012). Obesity and metabolic syndrome and functional and structural brain impairments in adolescence. *Pediatrics*, 130(4), e856-864. doi: 10.1542/peds.2012-0324
- Yokum, S., Ng, J., & Stice, E. (2012). Relation of regional gray and white matter volumes to current BMI and future increases in BMI: a prospective MRI study. *Int J Obes (Lond)*, 36(5), 656-664. doi: 10.1038/ijo.2011.175
- Yu, Z. B., Han, S. P., Cao, X. G., & Guo, X. R. (2010). Intelligence in relation to obesity: a systematic review and meta-analysis. *Obes Rev*, 11(9), 656-670. doi: OBR656 [pii]  
10.1111/j.1467-789X.2009.00656.x
- Yusuf, S., Wittes, J., Probstfield, J., & Tyroler, H. A. (1991). Analysis and interpretation of treatment effects in subgroups of patients in randomized clinical trials. *Jama*, 266(1), 93-98.
- Zeller, M. H., Reiter-Purtill, J., & Ramey, C. (2008). Negative peer perceptions of obese children in the classroom environment. *Obesity (Silver Spring)*, 16(4), 755-762. doi: 10.1038/oby.2008.4
- Zhao, J., Bradfield, J. P., Li, M., Wang, K., Zhang, H., Kim, C. E., et al. (2009). The Role of Obesity-associated Loci Identified in Genome-wide Association Studies in the Determination of Pediatric BMI. *Obesity*, 17(12), 2254-2257. doi: 10.1038/oby.2009.159
- Zimmerman, F. J., & Christakis, D. A. (2005). Children's television viewing and cognitive outcomes: a longitudinal analysis of national data. *Arch Pediatr Adolesc Med*, 159(7), 619-625.

## **8. Appendices**

### **8.1 Contribution to research**

#### **8.1.1 Contribution to the systematic (Cochrane) review (study 1)**

The systematic review and meta-analysis on “Lifestyle interventions for improving school achievement in overweight or obese children and adolescents” was conducted by AM, DHS, SDS, and JS.

I contributed to the following aspects of this research:

- Development and drafting of the review protocol
- Development of the search strategy
- Literature search
- Study selection
- Data extraction
- Contact of trial authors to obtain additional information or unpublished data
- Data analysis
- Drafting of full review

DHS helped drafting the review protocol with input from SDS and JS. DHS and SDS assisted in developing the search strategy. DHS was the independent researcher to screen and select studies for inclusion in the review. SDS and JS were consulted to resolve disagreement. DHS assisted during the data extraction and analysis process. DHS and SDS gave regular input into the interpretation of findings and full review draft.

#### **8.1.2 Contribution to the qualitative study (study 3)**

The study described in chapter 5 entitled “Body weight and school experiences: Perception and beliefs of children and their parents” was developed and conducted involving the researchers AM, AN, YL, and DHS.

I contributed to the following aspects of this research:

- Development of the study design
- Development of the focus group/interview schedule
- Setting up collaborations with the weight management programme Get Going
- Obtaining ethical approval
- Recruitment of participants
- Conduct of focus groups/interviews
- Transcript of audio-recordings
- Data analysis and interpretation

AN assisted in the development of the focus group/interview questions and the study protocol, in particular to ensure ethical conduct given the vulnerable population group and the sensitive topic of research. AN cross-checked the data analysis process and gave input for a suitable presentation of findings.

YL assisted and double checked the focus group/interview transcripts for correctness. DHS helped to get the collaborators involved in this study and to develop the study design.

## **8.2 Chapter 3**

### **8.2.1 Search strategy**

**Ovid MEDLINE**

1950 to 17 February 2012, searched on 22 February 2012 [2145 records]

1946 to April Week 4 2013, searched on 7 May 2013. Limited to ED=20120217-20130507 [1009 records]

- 1 exp Overweight/
- 2 Body Weight/
- 3 (obes\$ or overweight or over-weight).tw.
- 4 exp Body Weight Changes/
- 5 (weight adj2 (loss or lost or losing or reduc\$)).tw.
- 6 (weight adj2 (gain\$ or increas\$)).tw.
- 7 exp body fat distribution/ or body mass index/ or skinfold thickness/ or waist-hip ratio/
- 8 (body weigh\$ or bodyweigh\$ or body mass\$ or bodymass or body fat\$ or bodyfat\$).tw.
- 9 Overnutrition/
- 10 (overeate\$ or over-eat\$ or overnourish\$ or over-nourish\$ or overnutrit\$ or over-nutrit\$).tw.
- 11 or/1-10
- 12 exp Child/
- 13 Adolescent/
- 14 (child\$ or schoolchild\$ or preschool\$ or pre-school\$ or schoolage\$ or school-age\$ or schoolboy\$ or schoolgirl\$ or boy\$ or girl\$ or preteen\$ or teen\$ or adolescen\$ or youth\$ or young people or young person\$ or pediater\$ or paediatric\$).tw.  
(1087380)
- 15 12 or 13 or 14
- 16 Exercise/ or Exercise Therapy/
- 17 Physical Exertion/
- 18 Motor Activity/
- 19 Sports/

- 20 sport\$.tw.
- 21 exp "Physical Education and Training"/
- 22 (physical adj3 (activit\$ or education\$ or exertion\$ or training)).tw.
- 23 exercise\$.tw.
- 24 exp diet therapy/
- 25 ((diet or dieting) adj5 (health\$ or weight\$)).tw.
- 26 (calorie adj3 (control or reduc\$ or restriction)).tw.
- 27 food choice\$.tw.
- 28 (fat camp\$ or weight loss camp\$).tw.
- 29 nutrition education.tw.
- 30 Nutrition Therapy/
- 31 behavior therapy/
- 32 Cognitive Therapy/
- 33 psychotherapy/
- 34 (behavio?r\$ adj3 (therap\$ or technique\$ or modif\$ or intervention\$)).tw.
- 35 (cognit\$ adj3 (therap\$ or technique\$ or modif\$ or intervention\$)).tw.
- 36 CBT.tw.
- 37 (psychotherap\$ or psycho-therap\$).tw.
- 38 family therapy/
- 39 (family adj3 (therap\$ or intervention\$)).tw.
- 40 family-based.tw.
- 41 sedentary lifestyle/
- 42 (sedentary adj3 (lifestyle or behavio?r\$)).tw.
- 43 video games/

44 television/  
 45 (television or tv).tw.  
 46 "screen time".tw.  
 47 (psycho-social or psychosocial).tw.  
 48 exp Health Promotion/  
 49 Health Education/  
 50 (health\$ adj3 (promot\$ or educat\$ or lifestyle)).tw.  
 51 lifestyle/  
 52 (lifestyle\$ or life-style\$).tw.  
 53 ((video or computer) adj game\$).tw.  
 54 or/16-53  
 55 11 and 15 and 54  
 56 randomized controlled trial.pt.  
 57 controlled clinical trial.pt.  
 58 randomi#ed.ab.  
 59 placebo\$.ab.  
 60 drug therapy.fs.  
 61 randomly.ab.  
 62 trial.ab.  
 63 groups.ab.  
 64 or/56-63  
 65 exp animals/ not humans.sh.  
 66 64 not 65  
 67 55 and 66

## 8.2.2 Additional methods

Method item	Additional methods
Measures of treatment effect	<p>For <b>dichotomous data</b> the outcomes will be summarised as a risk ratio (RR) with a 95% confidence interval (CI). Using risk ratio rather than odds ratio minimises misinterpretation of the occurrence of the treatment effect and avoids subsequent conversion of odds ratios into risk ratio for correct interpretation. In the ‘Summary of findings’ table, we will express dichotomous data as relative (risk ratio) and absolute (number of children per 1000) risk.</p> <p>For <b>ordinal data</b>, we will analyse longer ordinal scales (for example, Wechsler Intelligence Scale for Children) as continuous data (Higgins &amp; Green, 2011). When studies use short ordinal scales (for example, A to F classification of educational attainment), we will convert these to dichotomous data by combining adjacent categories and calculating the risk ratio (Higgins &amp; Green, 2011). Dichotomisation will be done according to the cut-offs considered as ‘pass’ or ‘fail’.</p>
Unit of analysis issues	<p><b>Cross-over trials.</b> We will only include data from the first period and to treat the data as from a parallel group trial where participants were allocated to a single intervention. Data from subsequent iterations are prone to bias, for example carry-over effects. We planned to conduct a sensitivity analysis to examine the robustness of the results including data from cross-over trials.</p> <p><b>Multiple time points.</b> We will analyse data of studies which reported results at more than one time point in a separate meta-analysis with comparable data of other studies at similar time points. We will group post-intervention</p>

	time points as immediately after intervention, one to five months, six to 11 months, 12 to 23 months and 24 months after intervention.
<b>Assessment of reporting biases</b>	Reporting bias will be assessed by using a funnel plot to evaluate the association between effect size and standard error, if a sufficient number of studies (at least 10 studies) are included in the review. An asymmetric plot may indicate publication bias or a real relationship between study size and effect size, as when larger trials have lower compliance rates and compliance is positively related to effect size. If we find such a relationship, we will explore clinical variation as a possible explanation. When the number of included studies is low, an asymmetric funnel plot may be due to heterogeneity in the intervention effect or chance.
<b>Data synthesis of continuous and dichotomous</b>	If similar outcome data are extracted as both dichotomous and continuous measures (for example, exam results expressed as either pass or fail or a percentage score) we used the inverse variance method to combine data; for this we converted the risk ratio to lnRR and standard error (SE) of lnRR to enter into Review Manager 5.2.
<b>Subgroup analysis and investigation of heterogeneity</b>	<p>Subgroup analyses within this review is intended to focus on the following.</p> <p>Participant characteristics</p> <ul style="list-style-type: none"> <li>• Age (preschool versus primary or elementary school versus secondary or high school)</li> <li>• Gender (male versus female)</li> <li>• Weight status (overweight versus obese)</li> <li>• Location (low and middle income countries versus high income countries)</li> </ul>



	<p>Study design characteristics</p> <ul style="list-style-type: none"> <li>• Setting (home versus clinic versus school versus community)</li> <li>• Intervention duration (&lt; 6 months versus ≥ 6 months)</li> <li>• Type of intervention (single-component versus multicomponent; energy balance intervention versus behavioural interventions)</li> <li>• Type of outcome assessment (formal educational assessment versus non-formal assessment (for example, research only data))</li> </ul> <p>These subgroups are exploratory because they are based non-experimental (cross-sectional studies) and large numbers of subgroup analyses may lead to misleading conclusions (Oxman &amp; Guyatt, 1992; Yusuf et al., 1991). Therefore, when performing subgroup analysis we will treat any conclusions with caution.</p>
--	--

### 8.2.3 Characteristics of included studies

Ahamed et al., 2007	
Methods	<p>Study design: cluster randomised controlled trial</p> <p>Randomisation: Schools were stratified by size and geographic location. Randomisation of schools into three groups (2 intervention groups and 1 control group)</p> <p>Sequence generation: not reported, Allocation concealment: not reported</p> <p>N schools = 10 (7 intervention schools, 3 control schools)</p> <p>Blinding:</p> <ul style="list-style-type: none"> <li>- children: blinding to true purpose of the study not reported</li> <li>- providers: blinding to true purpose of the study not reported</li> <li>- outcome assessor: not reported</li> </ul> <p>Length of intervention: 1 school year, Follow-up: immediately post-intervention</p> <p>Unit of analysis: child</p> <p>Exclusion criteria: "school already undertaking a school-based physical activity program"</p> <p>Attrition (children): 29.1%</p> <p>Analysis: Authors provided raw data. Reviewers analysed the data using the independent t-test adjusting for the design effect. No adjustments for confounders were performed</p>
Participants	<p>N (randomised): 103 (78 intervention, 25 control)</p> <p>N (analysed): 73 (52 intervention, 21 control)</p> <p>Reasons for attrition: children moved schools or were absent on the day of testing (5 times higher in intervention than control school), school chose not to send participants` test results to the CAT-3 test center for scoring (control school), school administered the wrong test at follow-up (intervention school)</p> <p>Age range: 9-11 years (4th+5th grade), mean age: 10.1 ± 0.6 years</p>

	<p>Sex: 29% female; intervention group 48% female, control group 19% female</p> <p>Ethnicity: 43% Asian, 21% Caucasian, 9% other</p> <p>Geographic region: British Columbia, Canada</p>
Intervention	<p>Comparison: Action Schools! BC versus standard care</p> <p><b>Intervention:</b> Action School! BC is a comprehensive, multicomponent intervention providing tools for schools and teachers to promote physical activity and healthy eating in different settings. These include the school environment (healthy eating posters); scheduled PE, classroom action, family and community (e.g. walking school bus), extra-curricular (e.g. dance club), and school spirit (e.g. Hike across Canada challenge). Extra-curricular and school spirit activities were employed only by all small number of intervention schools.</p> <p>- <b>physical activity:</b> Classroom and/or school environment based physical activity for 15 minutes per day on 5 days/week delivered by trained classroom teachers. Activities included hip hop dancing, skipping, jumping, chair aerobics, yoga and strength work. This activity was in addition to 40 minutes physical education twice/week to engage children in 150 minutes physical activity/week. Compliance to intervention was assessed by the classroom teacher in form of daily physical activity logs reporting type, duration and frequency.</p> <p>- <b>nutrition:</b> Across the different settings a fruit and vegetable (F&amp;V) intervention was employed focusing on increasing intake of F&amp;V, improving knowledge, attitudes and perceptions regarding F&amp;V, and strengthening willingness to try new F&amp;V.</p> <p>Standard care: usual school practice</p>
Outcomes	<p><b>Outcome 1 School achievement:</b> Total and subject specific scores for mathematics, reading and language assessed using the Canadian Achievement Test (CAT-3). The test was administered by the classroom teachers and scored for most but one school at the CAT-3 test centre. One school scored the test locally.</p> <p><b>Outcome 2 Obesity indices:</b> Weight and height were measured and BMI calculated. Overweight and obesity were defined based on the IOTF cut-offs and CDC BMI-for-age growth tables (overweight = BMI &gt;85th percentile).</p>
Notes	<p>(i) Authors kindly provided raw data for overweight/obese children.</p> <p>(ii) Sample size calculation was performed for total sample (normal weight and overweight/obese children)</p> <p>(iii) Funding sources: 2010 Legacies Now and the BC Provincial Health Service Authority in collaboration with the BC Ministry fir Health Research Scholar.</p>

Davis et al., 2011	
Methods	<p>Study design: randomised controlled trial</p> <p>Sequence generation: random allocation by statistician, stratified by ethnicity and gender</p> <p>Blinding:</p> <ul style="list-style-type: none"> <li>- children: blinded to true purpose of the study</li> <li>- providers: not possible in physical activity intervention</li> <li>- outcome assessor: yes</li> </ul> <p>Length of intervention: 13 weeks</p> <p>Follow-up: immediately after intervention</p> <p>Unit of allocation: child</p> <p>Unit of analysis: child</p> <p>Attrition: 5.2% (6/116)</p> <p>Analysis: Intention-to-treat analysis performed by last observation carried forward (LOCF) for all outcomes. Group differences were calculated by analysis of covariance. Adjustment of outcomes for the confounders gender, parental education, baseline scores, and ethnicity.</p>
Participants	<p>N (randomised) = 116 (56 intervention, 60 control),</p> <p>N (completed) = 110 (54 intervention, 56 control)</p> <p>N (analysed) = 116 (110 + 6 LOCF)</p> <p>Reason for attrition: refused posttest (N = 2 intervention, N = 3 control), excluded due to psychiatric illness (n = 1 control)</p> <p>Age range: 7-11 years, intervention group: mean (SD) = 9.3 (1.1); control group: mean (SD) = 9.4 (1.1) years</p> <p>Sex: intervention group 54% female; control group 62% female</p> <p>Ethnicity: Intervention group , 64% Black , 36% White; control group 58% Black, 42% White</p> <p>Inclusion criteria: children aged &gt;11 or &lt; 7 years, BMI 85th percentile relative to CDC 2000 US growth charts, taking medication for attention deficit disorder when diagnosed</p> <p>Exclusion criteria: regular physical activity &gt; 1 hour/week, medical condition that affects outcome or limits intervention participation, participation in another study, on medication other than for attention deficit disorder mean weight status at entry: intervention group BMI z-score = 2.0(0.43); control group BMI z-score = 2.1(0.45)</p> <p>Geographic region: Georgia, USA</p>

Intervention	<p>Comparison: aerobic exercise group versus standard care</p> <p><b>Intervention:</b> Aerobic exercise group for 40min per day, 5 times per week over a mean total length of 13 weeks. Five minutes warm up phase consisting of brisk walking and static and dynamic stretching. Activities were selected based on ease of comprehension, fun, and eliciting intermittent vigorous movements. Children were encouraged to maintain a heart rate of &gt; 150 beats/minute during running games, tag games, jump rope, modified basketball and football. No competition or skill enhancement. Intervention session ended with a cool down including as water break, slow walking, static stretching. The intervention was delivered by qualified and trained research staff in an after school programme at the gymnasium of the Georgia Prevention Institute. Compliance was assessed by observing and recording attendance and average heart rate daily for each child. This study included a second intervention group which was not included in this review (see notes).</p> <p><b>Standard care:</b> continuation of usual activities</p> <p>All participating families were offered a monthly lifestyle education class covering the topics healthy diet, physical activity, and stress management.</p>
Outcomes	<p><b>Outcome 1 School achievement:</b> Broad mathematics and broad reading skills using the Woodcock-Johnson Test of Achievement III</p> <p><b>Outcome 2 Cognitive function:</b> Subscales for planning, attention, simultaneous, successive using the Das-Naglieri Cognitive Assessment System. Both tests were administered by a qualified psychologist and personnel with graduate training in psychological assessment.</p> <p><b>Outcome 3 Obesity indices:</b> Quote "Body weight (in shorts and t-shirt) and height (without shoes) were measured with an electronic scale (Detecto, Web City, MO) and stadiometer (Tanita, Arlington Heights, IL) and converted to BMI and a BMI z-score (Epi Info, Centers for Disease Control and Prevention, Atlanta, 2003)."</p>
Notes	<p>(i) Sample size calculation performed. 62 participants per group were estimated to provide 80% power to detect a difference between the groups of 6.6 units.</p> <p>(ii) The second intervention arm included a 20min physical activity intervention followed by 20 min of sedentary activities such as board games, card games, and drawing (low-dose intervention arm). This intervention group was excluded because the sedentary activities might have affected cognitive function without being defined lifestyle interventions.</p> <p>(iii) Funding Sources: National Institutes of Health, State of Georgia Biomedical Initiative grant to the Georgia Center for Prevention of Obesity and Related Disorders, Medical College of Georgia and the University of Georgia</p>

Johnston et al., 2013	
Methods	<p>Study design: Cluster randomised controlled trial</p> <p>Sequence generation: using a random sequence generator</p> <p>Blinding:</p> <ul style="list-style-type: none"> <li>- children: not possible in lifestyle intervention, unclear whether blinded to the true purpose of the study</li> <li>- providers: not possible in lifestyle intervention, unclear whether blinded to the true purpose of the study</li> <li>- outcome assessor: No</li> </ul> <p>Length of intervention: 2 years</p> <p>Follow-up: immediately after intervention</p> <p>Unit of allocation: schools</p> <p>Unit of analysis: child</p> <p>N schools = 7 (4 intervention schools, 3 control schools)</p> <p>Attrition: 21% (68/321)</p> <p>Analysis: Intention-to-treat analysis was performed by last observation carried forward (LOCF) for all outcomes. Results were generated using generalized linear models which were accounted for the cluster effect.</p>
Participants	<p>N (randomised) = 321 (N intervention = 186, N control = 135)</p> <p>N (followed) = 253 (N intervention = 153, N control = 100)</p> <p>Reasons for attrition: absent at follow-up (N intervention = 14, N control = 11), no longer at school (N intervention = 19, N control = 24)</p> <p>Age: 7-9 years, mean age: <math>7.8 \pm 0.4</math> (intervention group), <math>7.7 \pm 0.4</math> (control group)</p> <p>Sex: intervention group 38.2% female, control group 45.9% female</p> <p>Ethnicity: intervention group - Hispanic 27.4%, Black 26.9%, Asian 24.3%, White 21.5%; control group - Hispanic 29.6%, White 27.4%, Black 26.7%, Asian 16.3%</p> <p>Inclusion/exclusion criteria: not reported</p> <p>Geographic Region: Texas, USA</p>
Intervention	<p>Comparison: lifestyle education vs standard care</p> <p><b>Intervention:</b> whole-school lifestyle education programme facilitated by a health professional involving curriculum material taught by trained teachers, school meal modification and nutrition counselling. Compliance to the intervention was assessed through direct observation of teachers weekly by the health professional and verbal self-report from teachers.</p> <p><b>Lifestyle education/behaviour change:</b> Teachers were provided with 50 integrated lessons worth curriculum material aiming to improve healthy diet (increased fruit &amp; vegetable, breakfast, healthy snack, water consumption) and increase physical activity. Teachers were encouraged to teach lifestyle</p>

	<p>integrated lessons once a week, to conduct health related activities every 2 weeks and to hold a school-wide health event once per semester. The intervention component included provision of additional health information at school functions by health professional and involvement of school libraries, computers, art, music and physical education in delivery/complementation of lifestyle education.</p> <p><b>Nutrition/Diet:</b> Modification of school meals towards nutrient dense food. Nutrition counselling was provided on an informal basis by a school nurse.</p> <p><b>Standard care:</b> Even though intervention material was provided to control schools teachers reported using the material once a month or less.</p>
Outcomes	<p><b>Outcome 1 School achievement:</b> End of year final grades for reading, mathematics, and science summarized as Grade Point Average (GPA) obtained from school records. The grade scale comprises scores between 0 and 100 points for each subject.</p> <p><b>Outcome 2 Obesity indices:</b> age and gender-specific BMI percentiles and BMI z-scores obtained from measured weight and height and by using formulas and data tables provided by the Centers for Disease Control and Prevention (CDC). Overweight was defined as a BMI 85th percentile.</p>
Notes	<p>(i) authors were contacted</p> <p>(ii) No sample size calculation was reported. Thus, this study might be of risk of a Type 2 error.</p> <p>(iii) Funding source: not disclosed</p>

Staiano et al., 2013	
Methods	<p>Study design: randomised controlled trial</p> <p>Randomisation: allocation stratified by gender</p> <p>Sequence generation: could not be obtained</p> <p>Blinding:</p> <ul style="list-style-type: none"> <li>- children: blinded to true purpose of the study</li> <li>- providers: blinded to true purpose of the study</li> <li>- outcome assessor: yes</li> </ul> <p>Length of intervention and follow up: 10 weeks intervention</p> <p>Follow-up: immediately post-intervention</p> <p>Unit of allocation: child</p> <p>Unit of analysis: child</p> <p>Inclusion/exclusion criteria: BMI &gt; 75th percentile relative to CDC 2000 US reference growth charts</p> <p>Attrition: 27.0% (20/74)</p> <p>Analysis: 3 (conditions) x 2 (gender) analysis of variance, no adjustment for confounders reported</p>
Participants	<p>N (randomised) = 74 (28 in competitive group 1, 27 in cooperative group, 19 in control group),</p> <p>N (completed) = 54 (19 per intervention group, 16 in control group)</p> <p>Reason for attrition: self-consciousness due to obesity, school truancy or drop-out, school transfer, lack of interest, pregnancy, safety concerns about walking home in the dark, sports practice time conflicts, academic tutoring time conflicts, frequent headaches, and an injury outside of the program that required crutches. School administrators removed three students from the program due to behavioral infractions external to the exergame intervention.</p> <p>Age range: 15-19 years, mean = 16.5 years</p> <p>Sex: 57% female</p> <p>Ethnicity: all Black</p> <p>weight criterion: Overweight = BMI 85th percentile, obese = BMI &gt; 95th percentile relative to CDC 2000 US reference growth charts</p> <p>weight status at entry: Mean BMI = 93.9th percentile; overweight N = 12, obese N = 37</p> <p>Setting: school</p> <p>Geographic region: Washington D.C., USA</p>
Intervention	<p>Comparison: competitive physical activity vs standard care, cooperative physical activity vs standard care</p> <p><b>Interventions:</b> Nintendo Wii EA Sports Active exergame played in either competitive condition individually or in cooperative condition in pairs for 30-60 minutes, 5 days per week over a period of 10 weeks in total. Fitness video game included cardio activities (e.g. inline skating), sports games (basketball, volleyball, tennis, baseball), and strength training. Exergame routine was the same for both intervention groups. The routines varied on daily bases and gradually increased in difficulty throughout the study. Children in the competitive group were encouraged to win by earning top scores</p>



	<p>and expending most calories each time they played. Children in the cooperative group were encouraged to earn the highest possible score and to expend the most calories as a pair. Children were supervised during the exergame sessions. Compliance was assessed through attendance.</p> <p><b>Standard care:</b> continuation of usual school lunch and/or after school activities (Quote: "Control participants continued usual daily activities, such as socializing with friends, tutoring, and sports team practice.")</p>
Outcomes	<p><b>Outcome 1 Cognitive function:</b> executive function (visual-spatial skills, response inhibition, motor planning, visual scanning, speed, cognitive flexibility) measured using the sub-scales Design Fluency and Trail-Making of the Delis-Kaplan Executive Function System. Tests were administered by trained researcher and coded by two research assistants and a third research assistant double-coded all tests.</p> <p><b>Outcome 2 Obesity indices:</b> Body weight change: Body weight measured clothed without shoes by paediatricians and nurse practitioners at the school-based wellness clinic. Body weight remained unadjusted for height.</p>
Notes	<p>(i) No sample size calculation was performed. Thus, this study might be of risk of a Type 2 error.</p> <p>(ii) Five of the study participants (2 boys, 3 girls) were not overweight or obese. However, this study was done with the intention for weight management and the number of normal weight children is small when allocated into control group and the two intervention groups.</p> <p>(iii) Participants attended on average 1 exergame session/week.</p> <p>(iv) The time point of the measurement of cognitive function potentially introduced a confounding effect of acute exercise on cognitive function.</p> <p>(v) Funding sources: The Robert Wood Johnson Foundation, Georgetown University</p>

Winter and Sass, 2010	
Methods	<p>Study design: cluster randomised controlled trial</p> <p>Allocation: units of allocation were schools, allocation procedure into intervention and control group not reported</p> <p>Blinding:</p> <ul style="list-style-type: none"> <li>- children: blinding to true purpose of the study not reported</li> <li>- providers: blinding to true purpose of the study not reported</li> <li>- outcome assessor: not reported</li> </ul> <p>Length of intervention: 24 weeks</p> <p>Follow-up: immediately post-intervention</p> <p>N schools = 4</p> <p>Unit of analysis: child</p> <p>Inclusion criteria: not reported</p> <p>Attrition (children): 27.5%</p> <p>Analysis: Raw data were provided to review authors. Missing data were imputed using the last observation carried forward (LOCF) method. Summary statistics were calculated. Sample size was adjusted for cluster effect.</p>
Participants	<p>N (recruited): 141 (70 in intervention group, 71 in control group)</p> <p>N (analysed): 125 (61 in intervention group, 64 in control group)</p> <p>Reasons for attrition: none reported</p> <p>Age: 3-5 years, mean age: 4.3 ± 0.54 years</p> <p>Sex: 50% female</p> <p>Ethnicity: "predominantly Latino of Mexican American origin"</p> <p>Geographic region: Texas, USA</p>
Intervention	<p>Comparison: Healthy &amp; Ready to Learn intervention versus standard care</p> <p><b>Intervention:</b> Implemented at home and in school by trained parents and teachers. Compliance to the intervention was assessed during weekly evaluations at teacher level. Parents were interviewed monthly.</p> <ul style="list-style-type: none"> <li>- <b>lifestyle education:</b> Parents and teachers read children's books on health-related themes including nutrition and obesity prevention.</li> <li>- <b>physical activity:</b> Teachers and parents were trained to increase children's time spent physically active in moderate to vigorous activity for 60 minutes/day. Activities were play-based and targeted specific gross motor skills. Physical activity equipment was provided.</li> </ul> <p><b>Standard care:</b> usual school curriculum and programmes different from the intervention</p>
Outcomes	<p><b>Outcome 1 School achievement:</b> Receptive vocabulary skills were assessed with the Peabody Picture Vocabulary Test III administered by trained researchers.</p>

	<b>Outcome 2 Obesity indices:</b> Weight and height were measured and BMI calculated. Overweight was defined as BMI 85th - 94th percentile and obesity was defined as BMI >95th percentile based on gender-specific CDC BMI-for-age growth tables.
Notes	(i) Authors provided raw data for characteristic and outcome data for overweight or obese children (ii) Funding sources: Baptist Health Foundation of San Antonio and The Max and Minnie Tomerlin Voelcker Fund

Wirt et al., 2013	
Methods	<p>Study design: cluster randomised controlled trial</p> <p>Randomisation: Schools were the unit of allocation. Stratified randomisation was based on number of classes in grade 1 and/or grade 2.</p> <p>N randomised = 91 schools (45 intervention, 46 control)</p> <p>N included = 86 schools (44 intervention, 42 control)</p> <p>Blinding:</p> <ul style="list-style-type: none"> <li>- children: blinded to true purpose</li> <li>- providers: blinded to true purpose</li> <li>- outcome assessor: yes</li> </ul> <p>Length of intervention: 1 year</p> <p>Follow up: immediately post-intervention</p> <p>Inclusion criteria: Teacher participation in the program in the school year 2010/2011, informed consent of the school heads, teachers and parents</p> <p>Exclusion criteria: no possibilities to collect the necessary data at the school, insufficient number of parental consent to collect their child's data</p> <p>Unit of analysis: child</p> <p>Attrition (children): 24.3%</p> <p>Analysis: Authors provided means and standard deviation of raw data. Sample size was adjusted for cluster effect.</p>
Participants	<p>N (included): 37 (23 overweight, 14 obese)</p> <p>N (completed): 30 (20 intervention group, 10 control group)</p> <p>N (analysed): 28 (inhibition control); 27 (attention)</p> <p>Reasons for attrition (for normal weight and overweight study population): parental withdrawal from study, change of school, drop-out of class from study</p> <p>Age range: 6-8 years, mean age: <math>7.4 \pm 0.6</math> years</p> <p>Sex: 53% female</p> <p>Ethnicity: 52% with migration background</p> <p>Geographic region: Germany</p>
Intervention	<p>Comparison: Lifestyle education and physical activity versus no treatment (waiting list)</p> <p><b>Intervention:</b> Delivered in the primary school setting (class and recess) by specifically trained usual primary school teachers and at home with parent</p>

	<p>involvement. Compliance to experimental conditions was assessed through evaluation of other health promotion programmes and modifications in school and teaching environment.</p> <p><b>- Lifestyle education:</b> Healthy lifestyle education of twenty teaching sessions per year focusing on increased physical activity, reduced consumption of sugar-sweetened beverages and reduced screen time.</p> <p><b>- Physical activity:</b> Two physically active breaks per school day of 5-7 minutes and physical activity task to be performed at home involving parents</p>
Outcomes	<p><b>Outcome 1 Cognitive function:</b> Assessment of attention, mental flexibility and inhibition control using the computer-based test battery of attention for children KiTAP (Kinderversion der Testbatterie zur Aufmerksamkeitsprüfung) administered by trained assessors.</p> <p><b>Outcome 2 Obesity indices:</b> (i) BMI percentiles and standard deviation scores calculated based on measured body weight and height. Overweight = BMI &gt;90<sup>th</sup> percentile and obesity = BMI &gt; 97th percentile relative to the German reference population from 1985-1999. (ii) waist circumference was measured "halfway between the lower costal border and the iliac crest using a metal tape measure".</p>
Notes	<p>(i) Researchers kindly provided unpublished characteristics and outcome data for overweight or obese children.</p> <p>(ii) Results on both general study sample and overweight/obese sub-sample have not been published yet.</p> <p>(iii) Sample size calculation: Calculated for changes of anthropometric variables and running performance for total study sample.</p> <p>(iv) Funding source: Baden-Württemberg Stiftung gGmbH</p>

## 8.2.4 Risk of Bias Table

Ahamed et al., 2007

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote (from report): "Schools were then remotely randomized..." Quote (from email correspondence): "randomisation was done by random number draw by a third party "
Allocation concealment (selection bias)	Low risk	Quote (from email correspondence): "Yes, the 10 schools were randomized at once."
Incomplete outcome data (attrition bias)	High risk	Comment: Authors provided raw data of complete baseline and follow-up data sets only. Therefore, incomplete follow-up data were not imputed and included in analysis. Characteristics of missing data were not provided.
Selective reporting (reporting bias)	Low risk	Comment: All pre-specified attainment outcomes were reported.
Blinding of participants and personnel (performance bias)	Low risk	Quote (from email correspondence): "the primary purpose of Action Schools! BC was not to improve academic performance." Comment: Blinding of children and personnel regarding experimental condition is not possible in a lifestyle intervention. The email correspondence with authors confirmed that participants and personnel were blinded to the true purpose of the study.
Blinding of outcome assessment (detection bias)	Low risk	Quote (from report): "CAT-3 tests were administered by classroom teachers to [...] students in INT [intervention] and UP [usual practice] schools."
Comparability of baseline groups	Unclear risk	Quote (from report): "Schools were stratified by size and geographic location. [...] to accommodate different organisational structure of large versus small schools and different ethnic demographics between regions." Baseline characteristics between experimental groups were not significant besides school attainment scores which were higher in the control school than in the intervention school.
Other bias	Low risk	Comment: none detected

Davis et al., 2011

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote (from report): "... children were assigned randomly by a statistician..."  Quote (from the report Davis 2012): "...each participant was assigned a uniform (0,1) random number [...] within their respective ethnicity and sex group. If the number was between 0 and 0.33 the child was randomised to the low-dose group; between 0.34-0.67, to the high-dose group; and above 0.67, to the control group."
Allocation concealment (selection bias)	Low risk	Quote (from email correspondence): "I ensured allocation concealment by not permitting randomization by the statistician until baseline testing was completed. Only then were they randomized and their assignments communicated to the study coordinator, who informed the families."
Incomplete outcome data (attrition bias)	Low risk	Comment: Provided participant flow chart indicated similar missing data in intervention and control group.  Quote (from report): "Analyses were conducted using the last observation carried forward imputation for the [...] children who did not provide posttest data."
Selective reporting (reporting bias)	Low risk	Comment: All previously reported outcomes were reported.
Blinding of participants and personnel (performance bias)	Low risk	True purpose of the study was blinded by advertising it as "trial of aerobic exercise on child's health" (quote from report).  Comment: Blinding of children and personnel regarding experimental condition is not possible in a physical activity intervention.
Blinding of outcome assessment (detection bias)	Low risk	Quote (from report): "...Outcome assessors were unaware of child's experimental condition..."
Comparability of baseline groups	Low risk	Comment: Comparable baseline groups present due to random allocation of participants into intervention and control group.
Other bias	Low risk	Comment: none detected



Johnston et al., 2013

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote (from report): "7 schools were randomized using a random number generator"
Allocation concealment (selection bias)	Unclear risk	Comment: No information provided.
Incomplete outcome data (attrition bias)	Low risk	Quote (from report): "Models were developed for both completers and intention-to-treat using the last observation carried forward (LOCF) method."
Selective reporting (reporting bias)	Unclear risk	Comment: No information provided.
Blinding of participants and personnel (performance bias)	Unclear risk	Comment: Blinding is not possible in lifestyle interventions. Unclear whether participants and personnel were blinded to the purpose of the study (in relation to the outcome school attainment)
Blinding of outcome assessment (detection bias)	Unclear risk	Comment: No information provided.
Comparability of baseline groups	Low risk	Quote (from report): "No differences were found between conditions with respect to baseline demographic or anthropometric variables." Comment: Baseline GPA of intervention and control group indicated no statistically significant difference between the experimental groups.
Other bias	Low risk	Comment: No further bias was detected.

Staiano et al., 2012

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Quote (from email correspondence): "An adult research coordinator drew a number to randomly assign condition. When conditions became imbalanced due to attrition, new participants were assigned consecutively to the next available condition to maintain sample size balance."
Allocation concealment (selection bias)	Unclear risk	Quote (from email correspondence): "Participants knew that they were assigned to 1 of 2 classrooms or else to the control group, but they did not know the research aim until the disclosure period at the end of the study."
Incomplete outcome data (attrition bias)	High risk	Comment: Analysis was performed with data where both baseline and post-intervention data were available. Therefore, study did not account for incomplete outcome data. No information on characteristics of missing data available.
Selective reporting (reporting bias)	Low risk	Comment: Dissertation was assessed and all previously stated outcomes were reported in the article.
Blinding of participants and personnel (performance bias)	Low risk	Comment: Blinding not possible in exercise intervention. Quote (from email correspondence): Children "did not know the research aim until the disclosure period at the end of the study". Comment: Personnel was also blinded to true purpose of the study (information obtained from email correspondence).
Blinding of outcome assessment (detection bias)	Low risk	Quote (from email correspondence): "The coders and data enterers were blinded to the participant's condition."
Comparability of baseline groups	Low risk	Comment: Comparable baseline groups present due to random allocation of participants into intervention and control group.
Other bias	High risk	Comment: Body weight change is an unreliable measure of adiposity as it does not account for age and gender-specific developmental variation.



Winter and Sass, 2010

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: No information provided. Unclear how random sequence was generated.
Allocation concealment (selection bias)	Unclear risk	Comment: No information provided.
Incomplete outcome data (attrition bias)	Low risk	Comment: Study authors provided raw data of the overweight/obese subgroup. For 31 participants were no follow-up outcome data available. Review authors imputed missing outcome data using the last observation carried forward method.
Selective reporting (reporting bias)	Low risk	Comment: The outcome reported was pre-defined.
Blinding of participants and personnel (performance bias)	Unclear risk	Comment: Blinding to lifestyle education and physical activity intervention not possible. Information whether participants and personnel (teacher and parents) were blinded to the true purpose could not be obtained.
Blinding of outcome assessment (detection bias)	Unclear risk	Comment: Information could not be obtained from study authors.
Comparability of baseline groups	Low risk	Quote 1 (from report): "Data [...] were matched on the basis of geographical location, size of centre, and demographic characteristics." Quote 2 (from report): "The centre chosen served families that were similar in ethnicity, income and level of parental education." Quote 3 (from report): "Each centre [...] used a common curriculum, teacher professional development, and parent training program."
Other bias	Low risk	Comment: none detected

Wirt et al, 2013

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote (from email correspondence): "random sequence generation performed using a computer software"
Allocation concealment (selection bias)	Low risk	Quote (from email correspondence): "Schools were randomised at once."
Incomplete outcome data (attrition bias)	High risk	Quote (from email correspondence): "Provided data are from a sub-sample of the total sample. Missing data were not imputed. Only completed baseline and follow-up data set were included in the analysis." Comment: No information on characteristics of missing data was available.
Selective reporting (reporting bias)	Low risk	Comment: Trial authors kindly provided unpublished data. Quote (from email correspondence): "Data on mental flexibility cannot be provided to date because test of plausibility has not been performed yet."
Blinding of participants and personnel (performance bias)	High risk	Quote (from email correspondence): "Children were not informed that the intervention might have a beneficial effect on cognitive function. Teachers, however, were informed that the intervention might improve cognitive function."
Blinding of outcome assessment (detection bias)	Low risk	Quote (from email correspondence): "Outcome assessor was blinded to experimental condition."
Comparability of baseline groups	Unclear risk	Quote (report): "Stratified randomisation based on number of classes in grade 1 and/or 2." Quote (from email correspondence): "Baseline groups did not differ in executive function and attention scores, ethnicity and obesity indices. Significant differences were detected for mean age (intervention group 7.22 years; control group 7.74 years) and gender distribution (intervention group: 60% boys; control group: 20% boys)."
Other bias	Low risk	Comment: none detected

## 8.3. Chapter 4

### 8.3.1 NHS Tayside Caldicott Approval

REC 1518/12

Information & Performance Scrutiny  
NHS Tayside  
Kings Cross  
Cleington Road  
Dundee  
DD3 8EA  
Tel: 01382 424058

Dr Laura Stewart  
Nutrition & Dietetic Dept.  
Perth Royal Infirmary  
8 Western Avenue  
Perth  
PH1 1NX

Date 3<sup>rd</sup> of August 2012  
Your Ref  
Our Ref 12/01  
Enquiries to Joseph Donnelly  
Extension 71058  
Direct Line 01382 424058  
Email joseph.donnelly@nhs.net

Dear Dr Stewart,

**Caldicott Approval for Study of Effect of Childhood Weight Management on Participants' Educational Attainment**

Attached to this letter is a copy of the completed Confidentiality Statement giving Caldicott Guardian approval to share patient data as described in your statement.

Thank you for your co-operation in providing the information requested by us in this process.

Please contact me should any queries arise from the application of this approval.

Yours sincerely

Joseph Donnelly  
CHI Administrator

Headquarters  
King's Cross, Cleington Road, Dundee DD3 8EA

Chairperson, Mr Alexander Watson OBE DL  
Chief Executive, Mr Gerry Marr

CONFIDENTIALITY STATEMENT - for users of person identifiable data



**User Details**

Name: Miss Anne Martin  
Position: Postgraduate Researcher  
Organisation: University of Edinburgh  
Address: University of Edinburgh  
Institute of Sport, PE and Health Science  
Holyrood Road  
Edinburgh, EH8 8AQ  
Tel: 0131 651 4127

**Sponsor Details**

Name: Dr Laura Stewart  
Position: Team Lead Dietitian  
Organisation: NHS Tayside  
Address: Nutrition and Dietetic Dept.  
Perth Royal Infirmary  
8 Western Avenue  
Perth, PH1 1NX  
Tel: 01738473784

**Data Protection Reg. No.**

2 8537226

**Data Requested :**

A Data Processing Specification must also be completed.

Patient's name, date of birth, address, gender, deprivation score (Deprat or SIMD), body mass index centile, weight, height, quality of life scores (obtained from Pedsq), programme entry date, whether completion of treatment, number of attended appointments, health indices (learning disability, additional needs, health problems)

**Co-Users of the Data :**

Alison Bell, Senior Health Informatics Centre Data Analyst

**Intended use of data (inc. publications) :**

Data are required for identification of eligible cohort. For investigation of research questions data will be important confounding variables. Data will be transferred to the TASC safe haven facilities at the Health Informatics Centre where data will be linked with educational attainment data from local authorities in Tayside and anonymised prior analysis. Anonymous data will be used for publication in a doctoral thesis, scientific journals and conferences. We will communicate anonymous results to local authorities and practitioners. Findings will be used to inform design of larger, definite study.

**User's Declaration**

I declare that I understand and undertake to abide by the rules for confidentiality, security and release of data received from NHS Tayside.

Signature

Date 16/07/2012

**Sponsor's Declaration (to be signed by a consultant if patient data is requested and the applicant is not of that status or is not medically qualified)**

I declare that the above named user of the data is a bona fide worker engaged in a reputable project and that the data requested can be entrusted to this person in the knowledge that they will conscientiously discharge their obligations in regard to confidentiality of the data.

Signature

Date

For NHS Tayside use only

Release authorised by

Date

Ref.No.

On completion, please return this form to:

Information Governance Officer  
NHS Tayside  
Ashludie Hospital



# CALDICOTT APPROVAL - DATA PROCESSING SPECIFICATION

To be submitted with application for Caldicott Approval



For each separate source of patient identifiable data that you intend to access in support of your study please provide the following information.

Data Source: (Medical Records/System Name)
Data base/electronic medical records of the Paediatric Overweight Service Tayside

Data Items: (list the data items that you will require from the named data source)			
Patient's name	Date of Birth	Address	Patient's gender
deprivation score (Depcat or SIMD)	Weight and Height	Body mass index centile	Health indices (learning disability, special needs, health problems)
Programme entry date	Completion/withdrawal	Number of attended appointments	Quality of Life score (Pedsql)

Data Source Contact Details: (who have you agreed access to the source data with?)	
Name: Laura Stewart	Designation: Dr
Base: Perth Royal Infirmary, 8 Western Avenue Perth, PH1 1NX	Tel No: 01738473784
Email address: LauraStewart3@nhs.net	

Data Storage Arrangements: (where arrangements are described in a supplied study protocol then reference to the relevant sections of the protocol can be used)	
Location: (NHS Tayside, University, etc.) TASC Safe Haven at the Health Informatics Centre (HIC)	Device to be held on (desktop, laptop, network storage, etc.) TASC Safe Haven HIC network
Access Controls (how will the data be protected from unauthorised access?) See study protocol section B.7 - B.9	Encryption: (will encryption be used to protect the data?) Yes, encryption will be used for data transfer.
Anonymisation: (how will the identity of individuals be protected) Personal data will be anonymised by a unique identifier.	Format: (spreadsheet, database, etc.) Data will be stored in form of a spreadsheet.

<p><b>If you intend to make contact with patients</b> identified through the processing of this data, indicate how this will be done and how you will ensure that it is appropriate to contact them.</p> <p>It is recommended that contact with patients is through correspondence signed by the patient's GP/Clinician or Head of Clinical Service.</p>

### 8.3.3 NHS Tayside Research and Development Management Approval



17 December 2012

Miss Anne Martin  
Flat 9  
35 Buccleuch Street  
Glasgow  
G3 6PL

Dear Miss Martin,

#### R & D MANAGEMENT APPROVAL - TAYSIDE

**Title:** Effect of childhood weight management on participant's educational attainment.

**Chief Investigator:** Miss Anne Martin

**Principal Investigator:** Miss Anne Martin

**Tayside Ref:** 2012PZ03

**NRS Ref:** N/A

**REC Ref:** N/A

**EudraCT Ref:** N/A

**CTA Ref:** N/A

**Sponsor(s):** University of Edinburgh

**Funder(s):** University of Edinburgh – Institute of Sport

Many thanks for your application to carry out the above project here in NHS Tayside. I am pleased to confirm that the project documentation (as outlined below) has been reviewed, registered and Management Approval has been granted for the study to proceed locally in Tayside.

Approval is granted on the following conditions:-

- ALL Research must be carried out in compliance with the Research Governance Framework for Health & Community Care, Health & Safety Regulations, data protection principles, statutory legislation and in accordance with Good Clinical Practice (GCP).
- All amendments to be notified to TASC R & D Office.
- All local researchers must hold either a Substantive Contract, Honorary Research Contract, Honorary Clinical Contract or Letter of Access with NHS Tayside where required ([http://www.nihr.ac.uk/systems/Pages/systems\\_research\\_passports.aspx](http://www.nihr.ac.uk/systems/Pages/systems_research_passports.aspx)).
- TASC R & D Office to be informed of change in Principal Investigator, Chief Investigator or any additional research personnel locally.
- Notification to TASC R & D Office of any change in funding.

Version 3 – 15/03/2012

- As custodian of the information collated during this research project you are responsible for ensuring the security of all personal information collected in line with NHS Scotland IT Security Policies, until destruction of this data.
- All eligible studies will be added to the UKCRN Portfolio <http://public.ukcrn.org.uk/>. Recruitment figures for eligible studies must be recorded onto the Portfolio every month. This is the responsibility of the lead UK site. If you are the lead, or only, UK site, we can provide help or advice with this. For information, contact Charles Weller – (01382) 383822 – [charles.weller@nhs.net](mailto:charles.weller@nhs.net) or Liz Livingstone – (01382) 383872 – [clivingstone@nhs.net](mailto:clivingstone@nhs.net).
- Annual reports are required to be submitted to TASC R & D Office with the first report due 12 months from date of issue of this management approval letter and at yearly intervals until completion of the study.
- Notification of early termination within 15 days or End of Trial within 90 days followed by End of Trial Report within 1 year to TASC R & D Office.
- You may be required to assist with and provide information in regard to audit and monitoring of study.

Please note you are required to adhere to the conditions, if not, NHS management approval may be withdrawn for the study.

#### Approved Documents

Document	Version	Date
Protocol	1.1	20/09/12
IRAS R & D Form	96906/365812/14/923	
SSI Form	96906/365825/6/36/ 138539/254183	
Sponsor signature on R&D form		28/09/12
Funding letter		25/10/12
CV – John Sproule		05/09/12
CV – Anne Martin		21/09/12
CV – David Saunders		20/09/12
CV – Laura Stewart		
Caldicott Guardian Approval		03/08/12

May I take this opportunity to wish you every success with your project.

Please do not hesitate to contact TASC R & D Office should you require further assistance.

Yours sincerely,



Elizabeth Coote  
R&D Manager

TAside medical Science Centre (TASC)  
Ninewells Hospital & Medical School  
TASC Research & Development Office  
Residency Block, Level 3  
George Pirie Way  
Dundee DD1 9SY  
Email: [liz.coote@nhs.net](mailto:liz.coote@nhs.net)  
Tel: 01382 383876 Fax: 013812 740122

Version 3 – 15/03/2012

## 8.3.4 Health Informatics Centre Data user Agreement



Health Informatics Centre



### HIC Data User Agreement

**Approved Data User** - is the project Principal Investigator (PI) or a person who is authorised by the PI to also have access to the Project Dataset. The Approved Data User must be an employee of NHS Tayside, NHS Fife or the University of Dundee. All project collaborators must sign and agree to abide by the terms of the HIC Data User Agreement.

Where a data user is not such an employee but is an external project collaborator, then they will be logged on the HIC Project Management System as an Approved Data User subject to the following:

a) The HIC Data User Agreement must also be signed by an authorised signatory from their organisation.

HIC will make the project data available to the Approved Data User by hosting the data on a HIC server, within HIC's Safe Haven environment and providing secure remote access to the server, rather than releasing the data externally.

#### Data User Responsibilities

All Approved Data Users are required to maintain the security and confidentiality of their project datasets in accordance with this agreement and the Data Protection Principles (see **Appendix A**). HIC encourages Approved Data Users to report inadvertent events that are in breach of the terms of the HIC Data User Agreement to enable improvements to be made. Contact the HIC Operations Manager in the first instance to report the incident, who will initiate a Significant Event Report.

- 1) Approved Data Users will not reuse the data for purposes outside the scope of each project; share it with colleagues who are not named project Approved Data Users; attempt to link it to other datasets; or to de-anonymise it.
- 2) Approved Data Users will only remotely access their centrally-held data within the HIC Safe Haven. Individual-level data is not permitted to be stored or transferred outside the safe haven.
- 3) When the project is complete the data and the analysis syntax used will be securely archived by HIC.
- 4) Approved Data Users will ensure that HIC and the Health Board responsible for initially providing data are acknowledged as data sources in all resulting reports and publications. Eg. "We acknowledge the support of the Health Informatics Centre, University of Dundee for managing and supplying the anonymised data and NHS 'XXX' (eg Tayside), the original data source"



## Signatures

### a) Approved Data User

By signing and dating below you confirm that you have read, understood and will abide by this HIC Data User Agreement and the Data Protection Principles in relation to data being provided to you from HIC. Any breach of this agreement will result in your access to HIC data being reviewed by the HIC Executive Committee, along with any other action deemed necessary. HIC has a duty to report serious legal or regulatory breaches to the appropriate authorities (such as the Data Protection Commissioner and professional regulatory bodies)

Name: Anne Martin  
Position: PhD student  
Signature: A Martin  
Date signed: 02 May 2013

### b) Student Supervisor

(Note: Where the Approved Data User is a student, this Declaration must be signed by the student's supervisor.)

By signing and dating below you confirm that you will ensure the above named Approved Data User has read, understood and will abide by this HIC Data User Agreement and the Data Protection Principles in relation to data being provided to him/her by HIC.

Name: DAVID SAUNDERS  
Position: LECTURER  
Signature: DM  
Date signed: 02/05/2013

### c) Project Collaborators/External Organisations

External project collaborators (Approved Data Users who are not employees of University of Dundee, Tayside Health Board or Fife Health Board) must have this section signed by an authorised signatory from their organisation.

Authorised Signatory for Project Collaborator's Institution to sign the following declaration:

"We declare that the above named data user is a bona fide employee of this Institution engaged in a reputable project for which all relevant required permissions have been granted, and that the data requested can be entrusted to this person in the knowledge that they will conscientiously discharge their obligations in regard to the confidentiality of the data. This Institution agrees to abide by the terms of this agreement and takes responsibility for ensuring that data users are knowledgeable of, and compliant with required statutory and regulatory permissions and Data Protection requirements, and will provide a secure working environment and suitable technical resources to meet this obligation."

We declare that we understand that any breach of this agreement will lead to the withdrawal of access to HIC data for this Institution and its staff, and that HIC has a duty to report serious legal or regulatory breaches to the appropriate authorities (such as the Data Protection Commissioner and professional regulatory bodies)."

Name: John Spraul

Position: HEAD OF THE INSTITUTE FOR SPORT, PE & HEALTH SCIENCES

Signature: Cpl Spraul

Date signed: 2.5.13

For and On behalf of: University of Edinburgh  
(Name of Institution)

### 8.3.5 Data Sharing Agreement Dundee City Council

Data Sharing Agreement between Dundee City Council and University of Edinburgh

#### Data Sharing Agreement

**Data Provider:**

Dundee City Council  
Dundee House  
50 North Lindsay Street  
Dundee  
DD1 1NL

**Applicant:**

Institute of Sport, PE & Health Science  
University of Edinburgh  
Holyrood Road  
Edinburgh  
EH8 8AQ  
Tel. 0131 651 4121

This agreement must be signed by both the Applicant (University of Edinburgh) and the Data Provider (Dundee City Council) prior to the sharing of any personally identifiable or sensitive data.

#### **1. Objective of the research entitled “Childhood weight management and participants’ educational attainment”**

The principal objective of this research project is to assess the feasibility to perform a data-linkage study which combines data collected by a childhood weight management service and educational data collected by local education authorities.

The secondary objectives are

- To yield comprehensive data on overweight and obese children who were referred to a childhood weight management programme to investigate the effects of such service on educational attainment. This will be achieved by linking data from the Paediatric Overweight Service Tayside (POST) with data from local education authorities.
- To inform the design of a larger definitive, pragmatic study which will investigate the impact of weight reduction programmes on the educational achievements of children across Scotland.

#### **2. Benefits of this data sharing initiative**

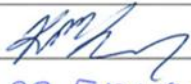
This data sharing initiative is important as it provides a pragmatic opportunity to investigate the effect of childhood obesity treatment on educational attainment using existing data. This research is important since healthy children and adolescents learn better and good education leads to better health. The current obesity prevalence in children and adolescents in Scotland means that the prevalence of cognitive and educational problems among children is high and likely to increase and this could cause future educational and employment problems in this population group. Findings of this research might assist to understand the negative

**15. Termination of Agreement**

The Applicant agrees that Dundee City Council reserves the right to terminate this agreement to share information immediately upon any breach of this agreement, the Data Protection Act 1998 or confidentiality by the approved user or one of his/her agents notwithstanding the terms of clause 12 above. Further, the Data Provider may terminate this Agreement at any time upon 3 months' notice. Upon termination, the Applicant shall cease forthwith to process the data and shall arrange for the prompt and safe return of all data belonging to the Data Provider to the Data Provider, together with all copies of the data in its possession or control, including all copies held by HIC.

**16. Authorised signatory for Data Provider**

Dundee City Council accepts the conditions outlined in the Agreement and agrees to abide by them at all times.

Name of authorised signatory	KENNETH JAMES MCKAIG
Position	LEGAL MANAGER
Organisation	DUNDEE CITY COUNCIL
Address	21 CITY SQUARE, DUNDEE
Telephone number	01382 434000
Email	
Signature	
Date	22 FEBRUARY 2013

X DCC

**16a. Witnesses to above signature**

I, the undersigned, have witnessed the above signature.

<b>Witness 1</b>			
Name:	JULIE ELLEN MURRAY		
Position:	SOLICITOR		
Signature:			
Date:	22 February 2013		

**17. Authorised Signatory for Applicant**

I, the undersigned, acknowledge and approve this application to receive information from Dundee City Council for the purposes described in this application.

<b>Name of authorised signatory</b>	Wendy Nicholson
<b>Position</b>	Head of Business Development
<b>Organisation</b>	EDINBURGH RESEARCH & INNOVATION LTD UNIVERSITY OF EDINBURGH
<b>Address</b>	ALRICK BUILDING KINGS BUILDINGS MAYFIELD ROAD EDINBURGH EH9 3JL
<b>Telephone</b>	0131 651 4026
<b>Email</b>	WENDY.NICHOLSON@ED.AC.UK
<b>Signature</b>	W. Nicholson
<b>Date</b>	19th MAR 2013

**17a. Witnesses to above signature**

I, the undersigned, have witnessed the above signature.

<b>Witness 1</b>			
<b>Name:</b>	MARLYN GOODALL		
<b>Position:</b>	BUSINESS DEVELOPMENT OFFICER		
<b>Signature:</b>	Marlyn Goodall		
<b>Date:</b>	19/3/13		

## 8.3.6 Data Sharing Agreement Angus Council

Data Sharing Agreement between Angus Council and University of Edinburgh

### Data Sharing Agreement

<b>Data Provider:</b> Angus Council Angus House Orchardbank Business Park Forfar DD8 1AX	<b>Applicant:</b> Institute of Sport, PE & Health Science University of Edinburgh Holyrood Road Edinburgh EH8 8AQ Tel. 0131 651 4121
---	--

This agreement must be signed by both the Applicant (University of Edinburgh) and the Data Provider (Angus Council) prior to the sharing of any personally identifiable or sensitive data.

#### **1. Objective of the research entitled "Childhood weight management and participants' educational attainment"**

The principal objective of this research project is to assess the feasibility to perform a data-linkage study which combines data collected by a childhood weight management service and educational data collected by local education authorities.

The secondary objectives are

- To yield comprehensive data on overweight and obese children who were referred to a childhood weight management programme to investigate the effects of such service on educational attainment. This will be achieved by linking data from the Paediatric Overweight Service Tayside (POST) with data from local education authorities.
- To inform the design of a larger definitive, pragmatic study which will investigate the impact of weight reduction programmes on the educational achievements of children across Scotland.

#### **2. Benefits of this data sharing initiative**

This data sharing initiative is important as it provides a pragmatic opportunity to investigate the effect of childhood obesity treatment on educational attainment using existing data. This research is important since healthy children and adolescents learn better and good education leads to better health. The current obesity prevalence in children and adolescents in Scotland means that the prevalence of cognitive and educational problems among children is high and likely to increase and this could cause future educational and employment problems in this

**15. Breach of Agreement**

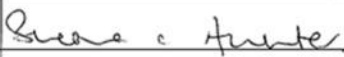
In the event of a breach of these presents by the Applicant or HIC, the Applicant shall be bound to remedy the breach within five working days of the breach coming to the attention of the Applicant or the breach being notified to the Applicant by Angus Council, whichever is the earlier. In the event that the breach is not resolved timeously, Angus Council will be entitled to terminate this Agreement forthwith.

**16. Termination of Agreement**

The Applicant agrees that Angus Council reserves the right to terminate this agreement to share information immediately upon any breach of this agreement, the Data Protection Act 1998 or confidentiality by the approved user or one of his/her agents notwithstanding the terms of clause 9 above. Further, the Data Provider may terminate this Agreement at any time upon 3 months' notice. Upon termination, the Applicant shall cease forthwith to process the data and shall arrange for the prompt and safe return of all data belonging to the Data Provider to the Data Provider, together with all copies of the data in its possession or control, including all copies held by HIC.

**17. Authorised signatory for Data Provider**

Angus Council accept the conditions outlined in the Agreement and agree to abide by them at all times.

<b>Name of authorised signatory</b>	SHEONA CRAIG HUNTER
<b>Position</b>	HEAD OF LAW & ADMINISTRATION
<b>Organisation</b>	ANGUS COUNCIL
<b>Address</b>	ANGUS HOUSE, ORCHARDSIDE BUSINESS PARK FORFAR
<b>Telephone number</b>	
<b>Email</b>	
<b>Signature</b>	
<b>Date</b>	21 NOVEMBER 2012

**17a. Witnesses to above signature**

I, the undersigned, have witnessed the above signature.

<b>Witness 1</b>			
Name:	ANNE ELLAWE GARNES		
Position:	SENIOR SOLICITOR		
Signature:	Anne E. Garnes		
Date:	21 NOVEMBER 2012		

**18. Authorised Signatory for Applicant**

I, the undersigned, acknowledge and approve this application to receive information from Angus Council for the purposes described in this application.

<b>Name of authorised signatory</b>	Wendy Nicholson
<b>Position</b>	Head of Business Development
<b>Organisation</b>	EDINBURGH RESEARCH & INNOVATION LTD
<b>Address</b>	EDINBURGH BUILDING KINGS BUILDINGS MAYFIELD ROAD EDINBURGH EH9 3JL
<b>Telephone</b>	
<b>Email</b>	
<b>Signature</b>	W. Nicholson
<b>Date</b>	23rd Nov 2012



### 8.3.7 Multiple Imputations models

Multiple Imputation regression models

Variable	Command	Prediction equation
totsessatt		[No missing data in estimation sample]
ageref		[No missing data in estimation sample]
gender		[No missing data in estimation sample]
simdquint~e		[No missing data in estimation sample]
disability		[No missing data in estimation sample]
scot		[No missing data in estimation sample]
abscdays3		[No missing data in estimation sample]
schstage2		[No missing data in estimation sample]
schoolid2		[No missing data in estimation sample]
schstage3		[No missing data in estimation sample]
schoolid3		[No missing data in estimation sample]
readpre	ologit	schstage2 schoolid2 writpre gender
_Ireadpre_2		[Passively imputed from (readpre==2)]
_Ireadpre_3		[Passively imputed from (readpre==3)]
_Ireadpre_4		[Passively imputed from (readpre==4)]
_Ireadpre_5		[Passively imputed from (readpre==5)]
readpost	ologit	schstage3 schoolid3 writpost bmisdpst gender abscdays3 totsessatt
_Ireadpos~3		[Passively imputed from (readpost==3)]
_Ireadpos~4		[Passively imputed from (readpost==4)]
_Ireadpos~5		[Passively imputed from (readpost==5)]
_Ireadpos~6		[Passively imputed from (readpost==6)]
bmipost	regress	totsessatt ageref gender simdquintile disability scot
writpre	ologit	schstage2 schoolid2 readpre gender
_Iwritpre_2		[Passively imputed from (writpre==2)]
_Iwritpre_3		[Passively imputed from (writpre==3)]
_Iwritpre_4		[Passively imputed from (writpre==4)]
_Iwritpre_5		[Passively imputed from (writpre==5)]
writpost~2	ologit	schstage3 schoolid3 readpost bmisdpst gender totsessatt abscdays3
_Iwritpos~3		[Passively imputed from (writpost==3)]
_Iwritpos~4		[Passively imputed from (writpost==4)]
_Iwritpos~5		[Passively imputed from (writpost==5)]
_Iwritpos~6		[Passively imputed from (writpost==6)]
bmisdpst	regress	bmipost totsessatt ageref gender scot simdquintile writpost readpost

## 8.4 Chapter 5

### 8.4.1 NHS Lothian REC Approval

#### Lothian NHS Board

Miss Anne Martin  
PhD Student  
University of Edinburgh  
Institute for Sport, PE and Health Science  
The University of Edinburgh  
Holyrood Road, Edinburgh  
EH8 8AQ

#### South East Scotland Research Ethics Committee 01

Waverley Gate  
2-4 Waterloo Place  
Edinburgh  
EH1 3EG  
Telephone 0131 536 9000  
Fax 0131 465 5789

[www.nhslothian.scot.nhs.uk](http://www.nhslothian.scot.nhs.uk)



Date 08 March 2013 (reissued version)  
Your Ref  
Our Ref

Enquiries to: Sandra Wyllie  
Extension: 35679  
Direct Line: 0131 465 5679  
Email: [Sandra.Wyllie@nhslothian.scot.nhs.uk](mailto:Sandra.Wyllie@nhslothian.scot.nhs.uk)

Dear Miss Martin

**Study title:** Body weight and school experiences: Perception and beliefs of children and their parents  
**REC reference:** 13/SS/0004  
**IRAS project ID:** 118199

Thank you for your letter of 05 March 2013, responding to the Committee's request for further information on the above research.

The further information was considered in correspondence by a sub-committee of the REC. A list of the sub-committee members is attached.

We plan to publish your research summary wording for the above study on the NRES website, together with your contact details, unless you expressly withhold permission to do so. Publication will be no earlier than three months from the date of this favourable opinion letter. Should you wish to provide a substitute contact point, require further information, or wish to withhold permission to publish, please contact the Co-ordinator Mrs Sandra Wyllie, [Sandra.Wyllie@nhslothian.scot.nhs.uk](mailto:Sandra.Wyllie@nhslothian.scot.nhs.uk).

#### Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation, subject to the conditions specified below.

#### Ethical review of research sites

NHS sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).



Headquarters  
Waverley Gate, 2-4 Waterloo Place, Edinburgh EH1 3EG

Chair Dr Charles J Winstanley  
Interim Chief Executive Tim Davison  
*Lothian NHS Board is the common name of Lothian Health Board*

### Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

*Management permission ("R&D approval") should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements.*

Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at <http://www.rdforum.nhs.uk>.

*Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.*

*For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.*

*Sponsors are not required to notify the Committee of approvals from host organisations*

**It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).**

### Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	Version	Date
Other: CV - A Martin		
Other: CV - D Saunders		
Other: CV - J Sproule		
Other: Bullying - what can I do booklet		
Other: Bullying - parent information leaflet		
Other: Child Information Letter (10-12 years old)	Version 1.1	07 February 2013
Other: Child Information Letter (13-15 years old)	Version 1.1	07 February 2013
Other: Parents/Carers Information Letter	Version 1.1	07 February 2013
Participant Consent Form: Assent Form - Young People	Version 1.1	07 February 2013
Participant Consent Form: For Parental Participation	Version 1.1	07 February 2013
Participant Consent Form: For Young Person	Version 1.1	07 February 2013
Participant Consent Form: Parents/Carers Consent Form for Child's Participation	Version 1.1	07 February 2013
Protocol	Version 1.1	07 February 2013
Questionnaire: Demographic	Version 1.1	07 February 2013
REC application		23 December 2012
Response to Request for Further Information		05 March 2013

#### Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

#### After ethical review

##### Reporting requirements

The attached document "After ethical review – guidance for researchers" gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The NRES website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

##### Feedback

You are invited to give your view of the service that you have received from the National Research Ethics Service and the application procedure. If you wish to make your views known please use the feedback form available on the website.

Further information is available at National Research Ethics Service website > After Review

13/SS/0004

Please quote this number on all correspondence

We are pleased to welcome researchers and R & D staff at our NRES committee members' training days – see details at <http://www.hra.nhs.uk/hra-training/>

With the Committee's best wishes for the success of this project.

Yours sincerely



pp  
Dr Janet Andrews  
Chair

Email: Sandra.Wyllie@nhslothian.scot.nhs.uk

Enclosures: *List of names and professions of members who were present at the meeting and those who submitted written comments "After ethical review – guidance for researchers"*

Copy to: *Marianne Laird  
Ms Karen Maitland, NHS Lothian Research & Development Office*

# South East Scotland Research Ethics Committee 01

## Attendance at Sub-Committee of the REC

### Committee Members:

<i>Name</i>	<i>Profession</i>	<i>Present</i>	<i>Notes</i>
Mr Lindsay Murray	Health & Safety Manager	Yes	
Dr Kevin Smith	Biochemist	Yes	

### Also in attendance:

<i>Name</i>	<i>Position (or reason for attending)</i>
Mrs Sandra Wyllie	Committee Co-ordinator



## 8.4.2 NHS Lothian Research and Development Office Approval

### NHS Lothian – University Hospitals Division

25 March 2013

Miss Anne Martin  
Flat 9  
35 Buccleuch Street  
Glasgow  
G3 6PL



Research &  
Development

Room E1.12  
The Queen's Medical  
Research Institute  
47 Little France Crescent  
Edinburgh  
EH16 4TJ

Tel: 0131 242 3330  
Fax: 0131 242 3343

Dear Miss Martin

**Letter of Clinical Research Access - only valid for the duration (no later than 31<sup>st</sup> October 2014) of study number 2013/P/PSY/02 entitled, "Body weight and school experiences: Perception and beliefs of children and their parents".**

The Research Governance Framework for Health and Community Care outlines the responsibilities of researchers who undertake research in a clinical setting. The framework has been compiled by the Scottish Executive Health Department to ensure all research meets high scientific and ethical standards.

This Letter of Clinical Research Access defines the requirements of Lothian Health Board (the "Board"), subject to which, you are granted rights of Clinical Research Access to carry out Approved Research in the course of your current PhD study programme at the University of Edinburgh (the "University").

On signature of this letter, subject to the Board undertaking appropriate Disclosure Scotland checks, you will be granted the right of Clinical Research Access which will continue, until such time as permission is withdrawn by the Board, in the circumstances mentioned in the next paragraph, or such time as you cease to be involved in Approved Research activity or your current study programme mentioned above.

In the event that you are in material breach of the requirements regarding Clinical Research Access as set out in this letter, or the Board considers that it is in the best interests of its patients, then in either circumstance the Board may withdraw Clinical Research Access with immediate effect by giving you written notice of this.

#### 1. Definitions

"Approved Research"	means research which has not only been approved by the University of Edinburgh, but has also received the approval of Lothian Health Board i.e. R & D Management approval, the necessary ethical approval and any further statutory approvals.
"Clinical Research Access"	means access to identifiable patient data, organs, tissue or other material.
"Confidential Information"	includes all information which has been specifically designated as confidential by the Board and any information which relates to the commercial and financial activities of the Board, the unauthorised disclosure of which would embarrass, harm or prejudice the Board.

Letter of Clinical Research Access – Final January 2011

"Principal Investigator"

means, in relation to a specific unit of research undertaken in a specific location, the researcher responsible for the overall conduct of that research activity.

## **2. Confidentiality and Disclosure of Information**

You must not divulge Confidential Information to any third party during the period of your research or any time thereafter without the proper authority having first been given.

All Confidential Information belonging to the Board, together with any copies or extracts thereof, made or acquired by you in the course of research shall be the property of the Board and must be returned to the Principal Investigator on completion of the research to which they relate or on the termination of your employment whichever is the earlier date. You will be entitled to retain any copies or extracts made or acquired by you in the course of research for references purposes only, provided that such copies or extracts are held and maintained in accordance with the provisions of the Data Protection Act 1988 and Caldicott principles.

## **3. Protection of Intellectual Property**

The protection of intellectual property is an important matter, and you will abide by the requirements of the Board and the University in relation to this matter. The Board and University deal with intellectual property matters on a case-by-case basis.

## **4. Obligations Arising from Data Protection Act 1998/IT Security**

Particular regard should be given to your responsibility to abide by the principles of the Data Protection Act 1998, a copy of which is available for reference in the Human Resources Department of the Board.

You must comply with the Board's Information Technology Security Policy on computer security, which is available within the Board R & D Department and on the Board Intranet site. Failure to comply with this will be brought to the attention of the University for investigation/action under the appropriate procedures. In addition failure to comply may lead to temporary or permanent withdrawal of permission to carry out research within the Board.

### **Patients**

In the course of your duties you may have access to Confidential Information regarding patients. You must not divulge such Confidential Information to anyone other than authorised persons, for example, medical, nursing or other professional staff as appropriate, who are concerned directly with the care, diagnosis and/or treatment of the patient. Where, in the course of your clinical research activity, new information comes to light that will or may impact on patient care, you will forthwith advise the relevant personnel within the Board.

### **Staff**

You must not divulge Confidential Information concerning individual members of staff to anyone without the authority of the individual concerned and the appropriate Principal Investigator.

If you are in any doubt whatsoever as to the authority of a person or body asking for information on patients or staff, or your own authority to divulge information, you must seek advice from the responsible person at your University.

These provisions are without prejudice to the NHS's stated commitments in the NHS Code of Openness. Further information is available from the Board's Human Resources Department.

#### **5. Disclosure of Concerns**

If you have any concerns about quality of service, health and safety, use of NHS money, or believe a colleague's conduct, performance or health may be a threat to patient care or to members of staff, you have a responsibility to raise these concerns without prejudice, directly with your line manager or the responsible person at the University.

You are protected against any harassment or victimisation resulting from such a disclosure. Therefore in the event that you are subjected to any form of harassment or victimisation, formal action will be taken against the perpetrators.

Concerns related to any research misconduct or fraud should be addressed similarly.

#### **6. Conflict of Interest**

As a general principle, you should not put yourself in a position where your official and private interests conflict, nor must you make use of your official/research position to further your private interests.

#### **7. Research Governance**

You are required to observe those requirements of the Research Governance Framework which are applicable and binding on you. The Research Governance Framework is available in the R & D Department and on the Intranet under Organisational/R&D. The framework relates to the management and monitoring, ethics, science, finance, health and safety aspects of research.

#### **8. Health and Safety**

The Board has a written Health and Safety Policy. The Board has a duty to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all its employees/individuals who work on the site. As an individual who works on the site, you have a duty to observe safe systems of work at all times, to take reasonable care of yourself and others who may be affected by your activities at work and to co-operate with the Board and others in meeting statutory requirements. Additionally, you are required to report all accidents "near misses"/ incidents to the responsible person at the University and to use any safety equipment provided for your protection.

Failure to comply with the provisions detailed above, without reasonable cause, will be brought to the attention of your employer for investigation/action under the appropriate procedures. In addition failure to comply may lead to temporary or permanent withdrawal of permission to carry out research within the Board.

#### **9. Hepatitis B**

For your own protection, you are advised to maintain Hepatitis B immunity status throughout the period during which you have been granted Clinical Research Access rights if your work brings you into contact with blood, other body fluids or fresh tissue.

#### **10. Professional Registration**

If your programme of study requires professional registration you must be fully registered with the appropriate professional body and maintain this registration throughout the period during which you have been granted Clinical Research Access rights. Evidence of this must be produced upon request.

#### **11. Personal Property**

Letter of Clinical Research Access – Final January 2011



The Board accepts no responsibility for damage to, or loss of, personal property. You are, therefore, advised to take out an insurance policy to cover your personal property.

If you need any further advice or guidance on any of the paragraphs set out above you should contact the responsible person at the University in the first instance.

If you agree to accept the conditions indicated above, please sign the statement of acceptance and return to the Board's R & D Department. A second copy of this letter is attached and should be retained by you for future reference as you will be required to provide this for evidence of clinical research access to each Principal Investigator with whom you work.

Yours sincerely

A handwritten signature in black ink, appearing to be 'DY', followed by a small dot.

Dr Douglas Young  
Principal R&D Manager

### 8.4.3 Moray House School Research Ethics Committee Approval



Research & Knowledge Exchange  
MORAY HOUSE SCHOOL of EDUCATION

The University of Edinburgh  
Old Moray House  
Holyrood Road  
Edinburgh EH8 8AQ

Direct Dial 0131 651 6388  
Switchboard 0131 650 1000

Email [rke-education@ed.ac.uk](mailto:rke-education@ed.ac.uk)  
<http://www.ed.ac.uk>

Anne Martin  
SPEHS  
Room 2.24  
St Leonard's Land

4 December 2012

Dear Anne

*Body weight and school experience: Perception and Beliefs of Children and their Parents*

The School of Education Ethics Sub-Committee has now considered your request for ethical approval for the studies detailed in the your application.

This is to confirm that the Sub-Committee is happy to approve the application and that the research meets the School Ethics Level 2 criterion. This is defined as "covering novel procedures or the use of atypical participant groups – usually projects in which ethical issues might require more detailed consideration but were unlikely to prove problematic".

A standard condition of this ethical approval is that you are required to notify the Committee, of any significant proposed deviation from the original protocol. The Committee also needs to be notified if there are any unexpected results or events once the research is underway that raise questions about the safety of the research.

Yours sincerely

A handwritten signature in blue ink, appearing to read 'S Bayne'.

Dr S Bayne  
Convener, School Ethics Sub-Committee

#### 8.4.4 Parents/Carers Information Letter



THE UNIVERSITY of EDINBURGH



*Institute for Sport, Physical Education & Health Sciences*

### ***Body weight and school experiences: Perception and Beliefs of Children and their Parents***

#### **Parents/Carers Information Letter**

---

Dear Parents/Carers,

You and your child are invited to take part in our research study. Before you decide we would like you to understand why the research is being done and what it would involve for you. This information sheet will help you decide whether or not you and your child want to take part. We will happily answer any additional questions you have.

#### **What is the purpose of this research study?**

Eating well and being active are important for child health but it may also influence children's experiences at school. Our study will involve talking to parents and children about what they think about body weight, Get Going and experiences at school.

#### **Why have we been invited to take part in this study?**

You and your child have been chosen because you participate in Get Going and your child is 10-15 years old.

#### **Do I and my child have to take part?**

No, it's optional; you do not have to take part. If you do agree to take part you can still change your mind at any time and do not have to explain the reason. The withdrawal will not affect the standard of care you and your child will receive.

**What do I and my child have to do if we agree to take part?**

The study is very simple. You and your child will both come together on one occasion to one of the Get Going venues for 3 hours to have a discussion with our researchers Anne Martin and Yvonne Laird.

You would each meet our researchers in a small group with 4-5 other children or parents you may already know from Get Going. Each meeting will last 60-90min. The child group will be first and followed by the parents group.

In the meeting there will be questions about what you think about taking part in Get Going and also about your child's time at school. Everyone can say what they think; there are no right or wrong answers. If you prefer not to answer some questions, that is fine too.

There is the possibility of individual interviews instead of group discussions involving the same questions. This may happen when the number of participating parents and children is too small for group discussions.

With your permission we will record the group discussions/interview with a digital voice recorder which allows us to analyse the responses later.

**What will happen with my child while I am in the group discussions?**

If your child wants to, he/she can take part in a physical activity group run by one of the Get Going coaches while you are participating in the group discussion with other parents. If your child does not want to take part in the physical activity group he/she can bring a book or a computer game and will be supervised by Yvonne. If you agree your child could also go home.

**Will other information be collected?**

Yes, with your permission we will request your child's weight, height and results of your child's Quality of Life questionnaire from the Get Going team.

We will also ask you to complete the enclosed questionnaire about your family characteristics which will take no longer than 5 minutes.

**What will happen with mine and my child's responses and data?**

The audio recordings will be uploaded to and securely stored on a NHS computer. The voice recordings will be deleted after they have been written as anonymous text.

With your permission we may contact you to ask for comments on our findings. This is basically to check that what we think parents and young people said is what you did say and mean. We would send you a summary report and ask for feedback by phoning you.

**Are there any other advantages/disadvantages and risks of taking part?**

There may be no direct advantages for you and your child by participating in this study. However, by taking part in this research you will help us to gain insight into what parents and children think about body weight and how it relates to experiences at school.

The group discussion may cause emotional discomfort when sensitive topics are discussed. You and your child do not have to answer questions if you feel uncomfortable. There will be a separate room available where you can go if you feel upset by the topic discussed for parts of the discussion. We will make sure that the discussions are as comfortable as possible for you and your child. In fact, you and your child may enjoy discussing your views with other parents and children in similar circumstances. The group discussions might be experienced as supportive.

Although there is a small risk of injury during the children's physical activity session (e.g. tripping or falling), this is no different from the usual Get Going activity session.

**What if there is a problem?**

It is very unlikely that you will come across a problem by participating in this study. Any complaint about the way you have been dealt with during the study will be addressed. If you have any complaints please contact the research team directly (0131 651 4127 or 07580191177 or email: Anne.Martin@ed.ac.uk) or contact the NHS Lothian Complaints Team (NHS Lothian Complaints Team, 2nd Floor, Waverley Gate, 2-4 Waterloo Place, Edinburgh, EH1 3EG, Tel: 0131 465 5708).

If you or your child tells us about he/she or anyone else being harmed we will inform the Get Going coach who then will activate the Edinburgh and the Lothians Interagency Child Protection procedures.

For further support related to your child's body weight please contact the Get Going team or your GP.

**Will my and my child's responses and data of this research be kept confidential?**

Yes, all collected data will be treated confidential. No one outside the study team will have access to your and your child's responses and information. We ensure that all data are stored securely. We will use and report the data with your name and address removed so that you cannot be recognised.

**What will happen to the results of the research study?**

The results of this study will be published in Ms Anne Martin's doctoral thesis and in research journals. The findings of the study will be presented at scientific conferences, and communicated to practitioners.

If you wish we can send you a summary report of the study and a copy of a publication.

**Who is organising and funding the research?**

The study is funded by the University of Edinburgh and organised in partnership with the NHS Lothian. The lead researcher is Ms Anne Martin who is conducting this research as part of her doctoral study. Also involved in this study are Yvonne Laird (doctoral student) and the researchers David Saunders and Ailsa Niven.

**Who has reviewed the study?**

Before any research goes ahead it has to be checked by Research Ethics Committees. They make sure that the research is OK for you and your child to do. This study has been checked and approved by the Research Ethics Committee of NHS Lothian and the University of Edinburgh.

**What do I do now if we want to participate?**

If you are happy to participate, please read, complete and sign the attached “Parents/Carers Consent Form”. Please bring all copies of the consent form to your Get Going coach on your final one-to-one session. This should give you a week to read and consider the information before giving consent.

Your child will be asked to sign the “Young Person Consent Form” in the final one-to-one Get Going session after Anne explained the study again. If the Get Going coach decides that your child is not in the position to decide for themselves to take part in the study we will ask you to sign the “Parental consent for child participation” form on his/her behalf. In this case your child will be asked to sign the “Young Person Assent Form”

With your permission we will inform your GP about your and your child’s participation in this study.

**Thank you for reading this. Please, feel free to ask any questions by contacting Ms Anne Martin (0131 651 4127, 07580191177 or [Anne.Martin@ed.ac.uk](mailto:Anne.Martin@ed.ac.uk)). If you would like to discuss this study with someone independent of the study team please contact: Jon Kelly (0131 650 9782 or [jon.kelly@ed.ac.uk](mailto:jon.kelly@ed.ac.uk))**

**If you are happy to participate Ms Anne Martin will contact you to schedule the discussion groups which will take place at the usual time and venue as for Get Going sessions.**

Kind regards,

---

**Anne Martin**

#### 8.4.5 Young Person Information Letter (age 10–12 years)



THE UNIVERSITY of EDINBURGH



*Institute for Sport, Physical Education & Health Sciences*



### ***Body weight and school experiences***

#### Young Person Information Letter (age 10–12 years)

---

Hello,

We are asking if you would like to join in a research project to find the answer to the question:

**Does your body weight influence your school experience?**

Before you decide if you want to join in, it's important to understand why the research is being done and what it will involve for you. So please read



this leaflet carefully. We will happily answer any extra questions you may have.

### WHO ARE WE?

Anne Martin and Yvonne Laird, researchers from the University of Edinburgh.

### WHY DO WE WANT TO DO THIS STUDY?

Eating well and being active are important for health but they may also influence young people's experiences at school. In our study we will listen to what young people on the *Get Going* programme think about their time at school.

### WHY HAVE I BEEN INVITED TO TAKE PART IN THIS STUDY?

Because you are taking part in *Get Going* and you are between 10-15 years old.

### DO I HAVE TO TAKE PART?

No. It is up to you. You can also pull out of the study at any time without giving a reason and this will not affect any the care you receive.

### WHAT DO I HAVE TO DO IF I WANT TO TAKE PART?

The study is very simple. You just come once, with your parent/carer, at the usual time and place for your *Get Going* sessions. There you would have a discussion with the researchers (Anne & Yvonne) in a small group with 4 or 5 other young people who you may already



know from *Get Going*. Girls will be in groups of girls only and boys will be with other boys.

Anne will ask your group questions about taking part in *Get Going*, body weight and your time at school. Everyone can say what they think; there are no right or wrong answers. If you prefer not to answer some questions, that is fine too. This will last about 1 hour.

After we have finished your parents will talk to other parents for about 1.5 hours. During this time you can take part in a fun activity group session with the others in your discussion group. You don't have to take part though, if so please bring something to keep you busy such as a book or computer game. You are also free to go if your parents agree.

If not many boys and girls want to take part in the group discussions, then Anne may ask you the questions on your own. If this happens, you can still decide not to take part if you don't want to. If you agree we will tell your family doctor you are taking part in this study.

### WHAT WILL HAPPEN TO THE ANSWERS I GIVE?

If you don't mind we will record the discussions with a voice recorder and later put the voice recordings on a computer. After typing out the words, all recordings of your voice will be deleted.

Your name won't appear in any written information. When we report the findings of our study we will use made-up names, so no one will know what you said. **ONLY** the researchers hear and see your answers. Your parents,

teachers and *Get Going* coach will NOT hear, see or be told about your answers.

We may contact you later again to check if we correctly understood what you said and meant if this is OK with you.

#### **WILL OTHER INFORMATION BE COLLECTED?**

Yes. If your parents agree, they will give us information about your family and school. If you agree, we will get your height and weight from your *Get Going* notes.

#### **ARE THERE ANY BENEFITS OR HARM AND RISKS OF TAKING PART?**

Taking part in this study may not benefit you. But you would help us understand experiences of young people on *Get Going* during their time at school.

There are not many risks to this study, but it might be that you feel uncomfortable in answering certain questions. If this happens you do not need to answer those questions. We will try to make the group discussion as comfortable and enjoyable as possible for you. You may even have fun talking about your school experiences with other young people from *Get Going*.

As with any other physical activity there might be a small risk of injury during the activity session (such as a trip or fall); however this is no different than during your usual *Get Going* sessions.

#### **WHAT IF THERE IS A PROBLEM?**

If you do not feel happy about something related to this study please tell us or your parents immediately. Your parents will then tell us. If you tell us about you or anyone else being hurt, then we will have to tell your *Get Going* coach. He/she will then follow the usual procedures to help you.

If you need further help related to your body weight please contact the Get Going team or your family doctor.

## WHAT WILL HAPPEN WITH THE INFORMATION FROM THE STUDY?

All answers and information collected will be part of Miss Anne Martin's work to become a researcher. We will share our findings of this study with other researchers and weight management coaches at meetings or in research magazines. We will make sure that nobody can tell that you have been taking part. We will not use your actual name when we report your answers.

**Thank you for reading this.** Please, feel free to ask any questions by sending an email to [Anne.Martin@ed.ac.uk](mailto:Anne.Martin@ed.ac.uk) or calling 0131 6514127. If you like to ask somebody outside the research team please ask Jon Kelly at 0131 650 9782 or [jon.kelly@ed.ac.uk](mailto:jon.kelly@ed.ac.uk).



If you are happy to take part in the study, please read the letters called "Young Person Consent Form" and "Young Person Assent Form". Please bring the forms to your final 1-to-1 Get Going session. Anne will explain the study to you again and answer questions after your final 1-to-1 Get Going session.

If you are happy to take part in the study your *Get Going* coach will ask you to sign the consent or the assent form.

**I very much hope that you will help us.**



---

**Anne Martin**

#### 8.4.6 Young Person Information Letter (age 13–15 years)



THE UNIVERSITY of EDINBURGH



*Institute for Sport, Physical Education & Health Sciences*



### ***Body weight and school experiences***

#### **Young Person Information Letter (age 13-15years)**

---

Hello,

We are asking if you would like to join in a research project to find the answer to the question:

**Does your body weight influence your school experience?**

Before you decide if you want to join in, it's important to understand why the research is being done and what it will involve for you. So please read

this leaflet carefully. We will happily answer any additional questions you may have.

### WHO ARE WE?

We are researchers from the University of Edinburgh. Anne Martin will carry out this study as part of her doctoral degree. Yvonne Laird will help Anne to carry out the study.

### WHY DO WE WANT TO DO THIS STUDY?

Eating well and being active are important for child health but it may also influence young people's experiences at school. In our study we will listen to what young people on the *Get Going* programme think about their time at school.



### WHY HAVE I BEEN INVITED TO TAKE PART IN THIS STUDY?

You have been invited because you are taking part in *Get Going* and because you are between 10-15 years old.

### DO I HAVE TO TAKE PART?

No. It is up to you. If you change your mind after you agreed to take part this is fine too. You can stop being in the study at any time without giving a reason. If you decide to stop, this will not affect the care you receive.

### WHAT DO I HAVE TO DO IF I WANT TO TAKE PART?

The study is very simple. All you need to do is come once, with your parents, at the usual time and venue as for the *Get Going* sessions. There you would have a discussion with Anne and Yvonne in a small group with 4-5 other young people who you may already know from *Get Going*. Girls will meet in groups of girls and boys will meet with other boys. Your parents will also meet with a group of other parents.

In the 1 hour group discussion Anne will ask you questions about taking part in *Get Going*, body weight and your time at school. Everyone can say what they think; there are no right or wrong answers. If you prefer not to answer some questions, that is fine too.

If not many boys and girls want to take part in the group discussions, then Anne may ask you the questions on your own. If this happens, you can still decide that you don't want to participate.

While your parents are talking to other parents for about 1.5 hours you can take part in a fun activity group session with the young people of your discussion group. You don't have to take part though. If you don't want to take part please bring something to keep you busy such as a book or



computer game. You are also free to go if your parents are happy for you to do so.

If you agree, we will tell your *GP* that you are taking part in this study.

### WHAT WILL HAPPEN TO THE ANSWERS I GIVE?

If you don't mind we will record the group discussion or interview with a voice recorder. Later we will put the audio recordings on a computer. The voice recordings will be deleted as soon as we have finished copying the recording into words. Your name won't be included in any of the information and when we report the findings we will use different names, so no one will know what you said. We make sure that only the researchers involved can hear and see your answers. Your parents, teachers and *Get Going* coach will not hear or be told about your answers.

We may contact you later again to check if we correctly understood what you said and meant if this is OK with you.

### WILL OTHER INFORMATION BE COLLECTED?

Yes. If your parents agree, they will give us information about your family and school. If you agree, we will get your weight and height from the *Get Going* notes.

### ARE THERE ANY BENEFITS OR HARM AND RISKS OF TAKING PART?

Taking part in this study may not benefit you. But you would help us understanding experiences of young people about body weight and their time at school.

There are not many risks to this study, but it might be that you feel uncomfortable in answering certain questions. If this happens you do not need to answer those questions. We will try to make the group discussion as comfortable and enjoyable as possible for you. You may even have fun talking about your school experiences with other young people from *Get Going*.

There might be a small risk of injuries during the activity session; however no more than in the usual *Get Going* activity group you have taken part in.

### WHAT IF THERE IS A PROBLEM?

If you do not feel happy about something related to this study please tell us or your parents immediately. Your parents will then tell us. If you tell us about you or anyone else being hurt, then we will have to tell your *Get Going* coach. He/she will then follow the usual procedures to help you.

If you need further help related to your body weight please contact the *Get Going* team or your GP.

### WHAT WILL HAPPEN WITH THE INFORMATION FROM THE STUDY?

All answers and information collected will be part of Miss Anne Martin's work to become a researcher. We will share our findings of this study with other researchers and weight management coaches at meetings or in research magazines. We will make sure that nobody can tell that you have been taking part. We will not use your actual name when we report your answers.

**Thank you for reading this.** Please, feel free to ask any questions by sending an email to [Anne.Martin@ed.ac.uk](mailto:Anne.Martin@ed.ac.uk) or calling 0131 6514127. If you like to ask somebody outside the research team please ask Jon Kelly at 0131 650 9782 or [jon.kelly@ed.ac.uk](mailto:jon.kelly@ed.ac.uk).

If you are happy to take part in the study, please read the letters called "Young Person Consent Form" and "Young Person Assent Form". Please bring the forms to your final 1-to-1 *Get Going* session. Anne will explain the study to you again and answer questions after your final 1-to-1 *Get Going* session. If you are happy to take part in the study your *Get Going* coach will ask you to sign the consent or the assent form.

I very much hope that you will help us.



---

**Anne Martin**

## 8.4.7 Parents/Carers Consent Form



THE UNIVERSITY of EDINBURGH



*Institute for Sport, Physical Education & Health Sciences*

### ***Body weight and school experiences: Perception and Beliefs of Children and their Parents***

#### **Parents/Carers Consent Form**

---

Please initial the boxes

1. I confirm that I have read and understand the information letter from 7 February 2013 (version 1.1) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand that my participation is voluntary and that I am free to withdraw any time, without giving any reason. ☐
3. I understand and agree that my GP will be informed that I take part in this study. ☐
4. I understand and agree that group discussions/interviews will be audio-recorded. ☐
5. I understand that my data will be treated confidential and that anonymity is assured. ☐
6. I understand and agree that collected data will be used for a doctoral thesis and will be published at scientific conferences and in scientific literature. ☐
7. I agree to take part in the above study. ☐

\_\_\_\_\_  
Name of Parent/Carer

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Telephone number

\_\_\_\_\_  
Mobile number

\_\_\_\_\_  
Name of person taking consent

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

## 8.4.8 Young People Consent Form



THE UNIVERSITY of EDINBURGH



*Institute for Sport, Physical Education & Health Sciences*

***Body weight and school experiences: Perception and Beliefs of Children  
and their Parents***

### Young Person Consent Form

---

Please write the 1<sup>st</sup> letter of your name and surname into the boxes

1. I confirm that I have read and understand the information letter from 7 February 2013 (version 1.1) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

☐

2. I understand that it is my decision to take part in this study and that I am free to stop at any time, without giving any reason and without my health care or legal rights being affected.

☐

3. I agree that my GP will be informed that I take part in this study.

☐

4. I understand and agree that group discussions/interviews will be audio-recorded.

☐

5. I understand that my data will be treated confidential and that anonymity is assured.

☐

6. I understand that if child protection issues are disclosed, then the researcher will tell Get Going who will then activate Edinburgh and the Lothians Inter-agency Child Protection Procedures.

☐

7. I understand that my weight and height from the Get Going notes will be passed on to the researchers involved in this study.

☐

8. I understand and agree that anonymous data will be used for a doctoral thesis and will be published at scientific conferences and in scientific literature.

☐

9. I am happy to take part in the above study and agree to take part.

☐

\_\_\_\_\_  
Child's name

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Telephone number

\_\_\_\_\_  
Mobile number

\_\_\_\_\_  
Name of person taking consent

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

## 8.4.9 Young Person Assent Form



THE UNIVERSITY *of* EDINBURGH



***Institute for Sport, Physical Education & Health Sciences***

***Body weight and school experiences: Perception and Beliefs of Children  
and their Parents***

### Young Person Assent Form

---

**Please circle all answers you agree with:**

Has somebody else explained this study to you?	Yes	/	No
Do you understand what this study is about?	Yes	/	No
Have you asked all the questions you want?	Yes	/	No
Have you had your questions answered in a way you understand?	Yes	/	No
Do you understand it's OK to stop taking part at any time?	Yes	/	No
Are you happy to take part in the study?	Yes	/	No

If any answers are "no" or you don't want to take part, don't sign your name!

If you do want to take part, you can write your name and the date below:

Your name \_\_\_\_\_

Date \_\_\_\_\_

The researcher who explained this project to you needs to sign too:

Print Name \_\_\_\_\_

Signature \_\_\_\_\_

Date \_\_\_\_\_

**Thank you for your help. Please bring the signed sheet to your final one-to-one Get Going session.**

## 8.4.10 Demographic Questionnaire



THE UNIVERSITY of EDINBURGH



### *Body weight and school experiences: Perception and Beliefs of Children and their Parents*

#### Demographic Questionnaire

Please answer each of the questions below or cross out the relevant circles.  
The information is strictly confidential and won't be shown to anyone.

#### **PART 1 Information about the parent/carer**

First Name	Surname
------------	---------

Address (including post code)
-------------------------------

How old are you?	What is your gender? o Male o Female
------------------	---

#### **What is your ethnic origin?**

- |                                       |                                    |
|---------------------------------------|------------------------------------|
| <input type="radio"/> White – British | <input type="radio"/> African      |
| <input type="radio"/> White – other   | <input type="radio"/> Arab         |
| <input type="radio"/> Asian           | <input type="radio"/> other, _____ |

**How many children do you have?** \_\_\_\_\_

**What is your level of education?**

- |   |                                       |
|---|---------------------------------------|
| <input type="radio"/> Standard Grade                          | <input type="radio"/> Master's degree |
| <input type="radio"/> GCSE or O Levels / Intermediate 1 or 2  | <input type="radio"/> Doctor's degree |
| <input type="radio"/> Highers or Advanced Highers or A levels | <input type="radio"/> Other           |
| <input type="radio"/> Bachelor's degree                       |                                       |

**What is your employment status?**

- |  |                                      |
|--|--------------------------------------|
| <input type="radio"/> Employed for wages                             | <input type="radio"/> A homemaker    |
| <input type="radio"/> Self-employed                                  | <input type="radio"/> A student      |
| <input type="radio"/> Out of work and looking for work               | <input type="radio"/> Retired        |
| <input type="radio"/> Out of work but not currently looking for work | <input type="radio"/> Unable to work |

**PART 2 Information about the participating child**

First Name

Surname

What is your child's date of birth?

What is your child's gender?

☐ Male ☐ Female

**What is your child's ethnic origin?**

- |                                       |                                    |
|---------------------------------------|------------------------------------|
| <input type="radio"/> White – British | <input type="radio"/> African      |
| <input type="radio"/> White – other   | <input type="radio"/> Arab         |
| <input type="radio"/> Asian           | <input type="radio"/> other, _____ |

**What is your child's living situation?**

- ☐ living with both parents  
☐ living with single mother/father



- ☐ living with other relatives
- ☐ living away from home with unrelated adult(s)
- ☐ other, please specify \_\_\_\_\_

**With how many siblings lives your child?**

\_\_\_\_\_

**What type of school attends your child?**

- ☐ public school
- ☐ private school
- ☐ special school (public or private)

**Which class is your child in currently?**

\_\_\_\_\_

**Did your child ever have to repeat a class in school?**

- ☐ YES
- ☐ NO

**Thank you very much for filling in the questionnaire. Please bring the completed questionnaire along with the signed consent form to the final one-to-one Get Going session.**

### 8.4.11 Focus group/interview Topic Guide

#### Focus Group/interview Topic Guide for Adolescents

Topic fields	Obj	Questions	Probes/Prompts	Notes
Introduction of participants		What's your name?		
		What are your hobbies?	What do you like to do in your spare time?	
		What is your favourite subject in school?	Why?	
Beliefs & attitude towards body weight	1	Do you think body weight matters for your health?	Why yes/no? Can you think of other benefits of a healthy body weight?	Focusing exercise: How does a healthy child look like? Please draw a healthy child.
	1	When did you become aware of your weight issue?	What/who made you aware? Clothes, situations, family/peers/GP?	
	2	Why did you feel you need to lose weight or participate in Get Going?		
	2	What do you think are the benefits of taking part in a programme like Get Going?		
Obesity & school experience	1	What does your typical school day look like?	When do you get up in the morning? How do you go to school (mode of transport, with whom)? How long are you in school for? How many subjects? What do you do during recess? What do you do after school and with whom?	
	1	Has anyone ever commented about your body weight?	What kind of things do they say? Who says those things? How do you react to those comments?	

	1	How do you get on with your classmates?	Who are your friends at school? What kind of things do you share with/tell your friends?
	1	Do your friends ever do or say anything that helps you to manage your weight?	What kind of things do they say or do?
	1	Do your friends do or say anything that makes it difficult for you to manage your weight?	What kind of things do they say or do?
	1	How do you get on with your teachers at school?	
<b>Weight management &amp; school performance</b>	1	How good do you think you perform in school compared to your classmates and friends?	How often do you miss classes? Which? What are the reasons for missing classes? How good are your marks? How much do you contribute to class work?
	1	Do you think that thinner pupils are better in school than bigger children?	Why do you think this could be/not be?
	2	Did you experience a change of your experience in school with classmate, friends, and teachers while you were taking part in Get Going?	What changed and how? - Relation to classmates? Contribution to class work? Change in attendance? Comments about body weight?
	2	Why do you think there have been (no) changes?	Internal (motivation, self-esteem, mood, concentration)? External (weight loss, peer relation, diet, physical activity)?

## Focus Group/interview Topic Guide for Parents

Topic fields	Obj	Questions	Probes/Prompts	Notes
<b>Introduction of participants</b>		What's your name and the name of your participating child? Can you tell us something special about your child?		
<b>Beliefs &amp; attitude towards child's body weight</b>	1	What do you think are important factors for the optimal development of your child?	Physical, mental, social, educational, environmental?	Focussing exercise: Sentence completion
	1	Do you think body weight matters for your child's health?	Why yes/no? What kind of problems can a person/a child have when he/she is overweight? Can you think of other benefits of a healthy body weight?	
	1	How do you determine if someone is overweight?	Body shape? Appearance? Health status?	
	1	What are your concerns about your child's body weight?		
	1	When did you become aware of your child's weight issue?	What/who made you aware?	
	2	Why did you feel your child needs to lose weight or participate in Get Going?		
	2	What do you think are the benefits of taking part in a programme like Get Going?	Benefits for you and your child?	
<b>Obesity &amp; school experience</b>	1	How does your child's weight affect his/her school experience?	Do you think your child is treated differently because of his/her body weight? Does your child tend to get into trouble in school? What kind of	

			trouble? Do you think this is related to his/her weight? How do you feel about it?
	1	How well you think your child performs in school compared to your classmates and friends?	How often does your child miss school? What are the circumstances? How good are the marks?
<b>Weight management &amp; school performance</b>	1	Do you think that thinner pupils are better in school than bigger children?	Why do you think this could be/not be?
	2	Did you experience a change of your child's performance in school while you were taking part in Get Going?	What changed and how? Relationship with classmates/friends, marks, attendance? Did you get feedback from teachers or your child? Why do you think there have been (no) changes?
	2	What do you think; could the knowledge of a beneficial impact of weight management on school performance encourage more families to take part in programmes like Get Going?	Why/Why not? How would you wish this information to be delivered? What information do parents need to make a decision regarding participation?